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DISTURBANCES IN SUBMARINE WORKING BY ELECTRIC TRAMWAYS.

ON another page of to-day's issue will be found the continuation and concluding portion of Mr. A. P. Trotter's paper lately read before the Institution of Electrical Engineers on the above subject, the first part of which appeared in the ELECTRICAL REVIEW of May 14th.

The disturbing influences to which all cables laid in the vicinity of an electric tramway system are exposed, often causes, as is well known, very serious embarrassment and delay, even if they do not render efficient working impracticable. On this account the question as to the best means of neutralising their effect calls for the serious consideration, no less of tramway engineers, than of those concerned in the working of cables.

It is certainly remarkable how patience, long practice and familiarity with a particular circuit, enables the analytical eye of an operator to distinguish true signals from spurious ones; but the prevalence of disturbing influences often means reduction of speed, if not the entire dislocation of the traffic.

It is not surprising, therefore, that cable managers consider this question of serious importance, more especially as the annoyance increases with the extension of the tram system. Although there is no question as to the baneful influence of electric tramways, it is not always clear how this influence is exerted. Any particulars tending to throw additional light on this subject will be read with interest, and we are therefore glad to be able to publish some experiments carried out at Cape Town in order to trace the disturbances to their source, and in this way ascertain their nature, with a view of applying a simple and effectual remedy.

Disturbances no doubt often arise, not from one only, but from several causes, viz., Induction from changes in the current carried by the insulated trolley wire and polarisation of several miles of ground on which tramways are laid, more or less parallel with the cable, varying according to the position and number of cars on the line, while at the same time the *earth* at the telegraph station may be constantly changing its potential, and causing currents to pass in and out of the signalling condensers.

Disturbances due to the last of these causes one might certainly expect to eliminate by removing the *earth* to a distance remote from electric tramway influences, and the fact that this remedy did not get rid of the frequent kicks on the recorder slip, seems to show that the inductive effect on the cable of the tramline was the chief cause of disturbance. This could therefore only be neutralised by an equal and opposite inductive effect.

Perhaps the best evidence that kicks arose from induction, and not from the station earth being polarised, is afforded by the fact that when the cable was duplexed at the station, no appreciable difference was noticed in the disturbance.

C

It was certainly rather remarkable that the military telegraph line (about 5 miles long) laid along the shore of the bay almost parallel to the cable did not reduce in some noticeable degree the disturbances, whether due to induction, polarised earth at the station, or both. This may perhaps be explained by the fact that the two lines were far from being equi-distant from the tramway line. If this is the reason, it is not surprising that a satisfactory balance was not obtained when using the currents induced by the tramway in neighbouring telephone lines for neutralising electric disturbances in the cable.

The starting and stopping kicks shown in fig. 2 are such as might easily result from momentary induced currents; for although the tops of the signals are of more rounded shape than a battery key signal at the recorder end would produce, this may, perhaps, be accounted for by the rise and fall of the inducing current being less abrupt. The second reversed throw across the zero line would be a natural consequence to the first impulse, as the shunt of 6,000 ohms would not make the recorder very dead-beat. That the amplitude of the kicks was noticed to be in proportion to the distance of the car from the works, would seem to offer a strong proof that disturbances resulted from induction rather than leakage, because the longer the length of line traversed by the current the greater would be its influence; and that this was greater on the Cape Town side is probably explained by this section being nearer to the cable and recorder instrument.

The second disturbance, described as a *splash* (fig. 3), is said to have thrown the siphon off the paper slip, and to be comparatively rare. So far as Mr. Trotter observed, this kick was always on the *dash* side of the zero line, and he, therefore, concludes that it was due to the sudden *switching on* of a considerable current. This is not clear, as it would seem reasonable to expect the reverse movement when the heavy current was switched off. Moreover, Mr. Trotter found the current reversed according as the tramcar was on the Cape Town or distant side of the works, so that the direction of the *splash* kick would be affected, one would suppose, by this fact also.

That the throw of the siphon coil should be positive or negative, depending on the side of the works where the car happened to be, is natural, as the works are nearly mid-way, and the direction of the current along the tram line changes accordingly.

The third kind of disturbance, or quiver, of the siphon line was no doubt, as Mr. Trotter suggests, due to the trolley jumping at insulators or points, and varying degrees of contact between the car wheels and the rails.

The several failures to neutralise induced waves in the cable by opposite induced waves from telephone lines is probably accounted for by the fact that really equal and opposite induced waves could not easily be secured by the means adopted on account of the widely differing conditions of the two circuits. Not only were their capacities and conductor resistances different, but they were not equi-distant from the tramway, and were therefore affected in very different degree.

In fig. 5, although the cable disturbances clearly occurred at the same moment as those on the telephone line, the kicks from the latter are said to have been about five times greater.

They are evidently much more rapid being practically on short circuit, and are consequently very sharp pointed; so rapid and violent has the kick been, that even the initial throw has only allowed time for a few detached specks of ink to be shaken from the siphon, and it is difficult to see how far the siphon really moved.

Mr. Trotter says that at first he thought that the rounded top of the ordinary kick was due to the capacity of the cable, but that fig. 4 (obtained with a Clark's cell through 100,000 ohms, where no capacity is used) shows that this is not the case. Fig. 4 shows the effect of a small wave slowed by a very high resistance, though not by capacity, while fig. 2 shows a signal slowed by a very large capacity and low resistance. The comparative slowness of both produce the rounded tops.

The object of the connections in fig. 6 are not very obvious, as the induced currents in the telephone line could not be expected to equilibrate induced currents in the cable sheathing, nor would the telephone line under these conditions have the same potential as the cable sheathing. The connections in fig. 7, moreover, would not be likely to do more than reduce the size of the cable disturbances, owing to the two condensers being in cascade.

With regard to the experiment illustrated in fig. 8, it is known that momentarily induced waves show little difference in the throw of a Thomson reflecting galvanometer until the resistance in circuit is increased by very many thousand ohms. The same result is noticed when a condenser having a very small capacity is charged, or discharged, through a very high resistance. On the other hand, since the cable current comes from a circuit having a very large capacity, a relatively small resistance affects the duration and amplitude of the charge or discharge recorded.

The experiment suggested by Mr. Rommel would seem to point to the tramway track as the chief source of inductive disturbance rather than the trolley line, but the conditions are not very clear, and might with advantage have been illustrated.

The suddenness of the kicks and the prompt return to zero shown in fig. 9, when the cable conductor was direct to the sheathing (without any condensers) seems also to show that leakage contributed very little to the disturbance.

Although the experiments led to no practical means of obviating the disturbances, they are certainly of great interest, inasmuch as they help to explain their nature.

Mr. Trotter says: "To non-cable electricians it is not easy to see why such disturbances should not be cancelled by equal and opposite induction." So far from this being impossible, it is the only way in which it could successfully be done, and the nearer the means employed conform to the electrical condition of the cable, the more perfect, of course, is the balance. In fact, the remedy finally resorted to at Cape Town of laying an earth cable for 5 miles or so over the line of the main cable got over the difficulty, simply because by its means an equal and opposite induction was set up on the earth side of the recorder instrument. The reason why the telephone and other lines failed to supply an efficient remedy would probably be the difficulty of producing in these the same amplitude and duration of induced waves as those which they were required to neutralise in the cable, for unless they exactly synchronised and coincided with each other in every respect, the intended remedy might even increase the disturbance. For instance, in duplex balancing one adjustment may produce an opposite, and to all appearance, the same size and shaped movement on the

recorder slip as the error in balance it is wished to compensate, but when applied, the disturbance is often found to be only aggravated or altogether changed in character, because the two are not identical in every respect, or do not take effect at precisely the same instant.

Were the disturbing force stationary, no doubt compensation would be much easier, but as it shifts its position as the cars move along, and the telephone lines experimented with were not specially laid in a direction having, throughout their length, the same relation to the tram line as the route followed by the cable, a satisfactory balancing of induced waves with the car at one end could not be equally good when the car was at the other end of the line.

It is said that a recorder connected between the conductor and sheathing of the newly laid *earth* cable, when the distant end was sealed, showed kicks in all respects similar to those from the old cable, but that an attempt to neutralise disturbances in the old cable by means of those in the new one was unsuccessful.

Considering the difference in the size of the waves formed in the new and old cables, this is not to be wondered at, for the charge taken up by the short cable, with its seaward end sealed, would be comparatively small; but directly the distant end was earthed, the induced charge would take full effect and develop a larger wave coinciding in direction and duration to the similarly induced waves in the old cable, and therefore capable of balancing them.

In the case of a laid cable, the plan adopted at Cape Town for the earth cable was evidently the simplest; but wherever a new cable is being laid it would be better, both for working purposes and repairs, to land the end at a point remote from electric tramways, and connect it to the station by one conductor of a twin-core cable, using the second conductor as the earth. When this is not practicable, connections between the conductor and sheathing of the main cable with the twin cores should be made some miles seaward of the cable landing.

Mr. Trotter's experiments and conclusions will doubtless be perused with interest by many who have had to contend with similar difficulties in working cables, and we hope that others will be induced to publish the result of their experience, in order to elucidate the subject further.

The existing Cable route to the East and Australasia.

One of the arguments most freely used against the durability of any cable passing through the Pacific Ocean, has been that any such cable must traverse regions riven by volcanic action; "argal," the greater including the less; and a cable being smaller than a volcanic region;—such cable must also be riven by volcanic action. This style of opposition has apparently been abandoned by those most intimately concerned in its use; and in so much that it has done little harm beyond inspiring some hyper-official mind with convenient catch-words, may be looked on as a failure. To any such, we suggest the perusal of "Much ado about Nothing!" It must be clear to those who have actually examined this matter, that the submarine cables at present connecting England with India, Australia, and the East *via* the Mediterranean, are in much greater danger from volcanic action than almost any route which could possibly be chosen for a cable through the Pacific. We learn that Vesuvius is again in eruption, and we know that there have recently been earthquake shocks in Greece. We remember that Etna and Stromboli exist, and that Santorin Island may again come into evidence. Closer still to the direct route of the existing cables between Gibraltar and Egypt, we find the position of the now submerged Graham Island, which within the memory of some of us astonished the Sicilian fishermen by its sudden appearance above the surface. It is needless, we presume, to point to the danger due to volcanic action which threatens, and has interrupted the cables, which, passing through the Java seas, unite us with Australia. Our readers may recall the various interesting accounts given in the press, of the outbreak at Krakatoa, perhaps the most striking instance, although far from being the only one in this district. With such knowledge before us we find difficulty in excusing those who can only admit of one side to the question, and who apparently without examination of the circumstances or without reasons given and evidence adduced, are pleased to give vent to a string of idle platitudes, based on vague and misleading statements, which have been abandoned even by their inventors.

Electrical Farming.

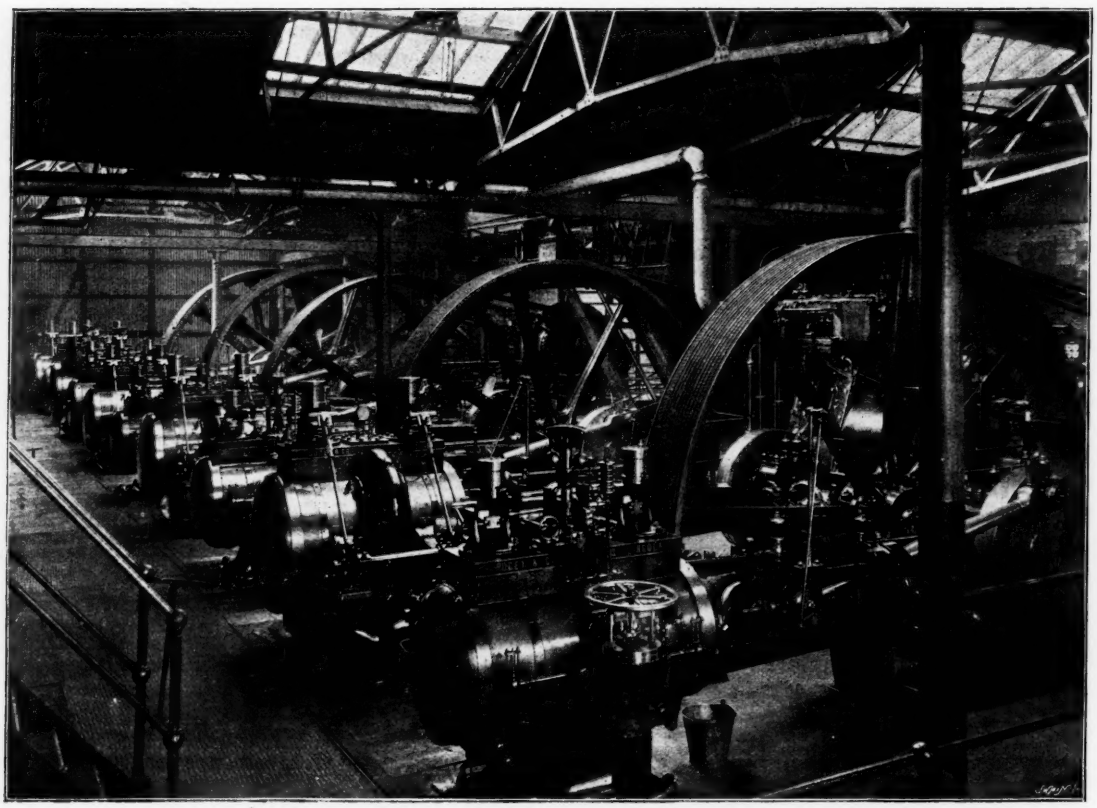
Every now and then we read in our American contemporaries accounts of experiments which have been conducted by enterprising farmers out West, with a view to adapting electrical power to the requirements of agriculture and general farming operations. We are not aware that in this country any serious attempt has been made to utilise such power on a farm, but then, in the practicable adaptation of scientific results, English people, and especially English farmers, are invariably behind. In a recent United States Consular Report, an extremely interesting electrical installation which exists on a farm at Mecklenburg in Germany, is described, and which actually is stated to be worked at a profit. The power is originally obtained from a small brook, the water of which drives a turbine at about 16 horse-power, connected to a continuous current dynamo. Of course there is a storage battery, by means of which the energy of the brook is stored up during the time when the farm machinery is not in operation. Conductors lead to all parts of the farm, driving motors for thrashing, sawing logs, straw cutting, pumping and small machine tools, the farthest motor being 1,800 feet from the dynamo. The plant is run at about 140 volts. This installation during the year furnished 34,000 horse-power hours of energy, including 120,000 lamp hours of lighting. The cost of the plant was $12,376, of which the electrical part figured at $7,140. The working expenses, including interest and depreciation, amounted last year to $1,428. The former working expenses were $1,713.60. This shows a difference of $285.60 in favour of electricity. But in addition to this there is gained the advantage that four horses can be dispensed with, whilst the remaining horses are always ready for use. In a measure the possession of a store of power enables the farmer to be nearly independent of weather; at least so far as the employment of his men is concerned. This is an advantage which can scarcely be reckoned up in £ s. d., but which, nevertheless, will be recognised by every practical man. In the farm in question electric light is of course supplied to all buildings including the sheds used for the various stock. Of course the brook was an important factor, and available water powers are not a universal adjunct on farm lands. In America, however, the inter-urban railway and the enterprising central station are gradually reaching out for the farm. Only recently a farm motor installation in Pennsylvania operated by single phase alternating current at a distance of nearly 5 miles from the central station was described by the *Electrical Engineer* (U.S.A.), as giving most satisfactory results. To farmers in this country all this may seem like a fairy tale, but even fairy tales sometimes become true, and it would be a good thing if some of our "gentlemen farmers," who spend so much money in experimenting with all kinds of expensive manure, would turn their attention, and a little of their capital, to the other aspect of farming, namely the saving of labour and the economy of power, and endeavour to demonstrate the possibility of replacing steam, animal, and man power, to some extent by means of power derived electrically.

D

THE ELECTRIC LIGHT ENGINES AT NEWCASTLE.

We illustrate a group of engines made by Robey & Company, Limited, of Lincoln, and working at the Newcastle-upon-Tyne Electric Supply Company, Limited, Pandon Dene, Newcastle-upon-Tyne.

The first pair of 250 H.P. was supplied in 1889, and consists of a high pressure engine having cylinder 16″ diameter, low pressure engine with cylinder 26½″ diameter, stroke 36″. A similar pair was supplied a few months later, and the following year (1890) a high speed engine for the day load was furnished. This is indistinctly seen in the photograph, but is a compound vertical engine with high pressure cylinder 11″ diameter, low pressure cylinder 18″ diameter × 12″ stroke, and making 200 revolutions per minute. In the



same year (1890) another coupled compound engine of 250 H.P. was supplied, similar to the foregoing, and the following year one of 350 H.P. having cylinders 19½″ and 33″ diameter × 40″ stroke, and again last year a still larger one of 500 H.P. with high pressure cylinder 20½″ diameter, low pressure cylinder 35″ diameter × 42″ stroke.

Each of the large engines drives a Mordey alternator by means of flexible cotton ropes.

A paper was read some time since by Mr. R. C. Jackson before the Institution of Electrical Engineers, giving full particulars of this installation, and referring specially to the fact of the small staff required to work the same owing to the construction of the engines being so simple that they required practically no attention.

Each of the large engines is fitted with Robey's patent trip expansion gear, which not only secures great economy in the use of steam, but also practically uniform speeds with great variations in load.

UNINSULATED PIPE FOR INTERIOR WIRING.

By V. ZINGLER, A.I.E.E.

(*Continued from page* 660.)

Joint Boxes, &c.—These may be either round or square, but the former lend themselves better for disposing of the joints. The pipes may either be screwed in or fastened by check nuts. All boxes should have a slightly concave bottom, with a hole in the centre to carry off moisture. Boxes over fittings such as electroliers, ceiling lights, &c., having a pipe running right down to the fitting should be so drilled that this pipe enters the side of the box. Otherwise water may get into the fitting.

All boxes should be as watertight as possible, as apart from condensation, they are the chief sources of moisture in the pipes, because when floors are washed water gets through the traps.

Tees, Elbows, &c., should never be used except for surface work, when the wire should be threaded through.

Diameter of Pipes.—No fixed rule can be laid down for this, as so much depends on the length of run, number of wires, &c. The writer has, however, found a certain rough rule useful, which may be taken as approximate for ordinary runs, viz.:—that the section of the pipe should not be less than three times the section of all the wires in it. This makes allowance for the possible future swelling of the insulation. It may, however, be said that the less wires there are in a pipe the better.

The following is a table based on the above rule. This gives the number of wires that will go into a pipe of a certain diameter, or the diameter of pipe required for a given number and size of wires. The section of pipes is calcu-

lated on the basis of 10 for ½ inch diameter, and that of the wires on the basis of three times the above.

Diameter of barrel.	Section.	Gauge of wires.	Section.
½ inch.	10	3/22	5
¾ inch.	22	3/20	6
1 inch.	40	7/20	11
1¼ inch.	62	7/19	12
1½ inch.	90	7/18	15
2 inches.	160	19/20	19
2½ inches.	250	19/19	21
3 inches.	360	19/18	26

In order to find the size of pipe for a given number of wires of same or different gauges, it is only necessary to add the different sections of these wires together, multiplying, of course, each time by the number of wires. The pipe required is that whose relative section is nearest to the sum obtained.

For instance, required the pipe for 6 — 3/20 wires, and 2 — 7/20 wires.

Total relative section of wires

$$= (6 \times 6) + (2 \times 11) = 58.$$

The nearest relative section of pipe to this is 62 = 1¼ inch diameter.

The above figures are approximate only.

Drops to Switch-points, &c.—No pipe should be smaller than ¾-inch. If possible, all bends in this size should be made cold. If the pipe is heated, it should afterwards be soaked in a solution of Smith's compound.

Drainage of Pipes.—All pipes with vertical bends, as under a girder, should have a hole drilled at the lowest point, as at A (fig. 3). The same applies to a pipe running down the wall to a bracket or switch point. This should have a

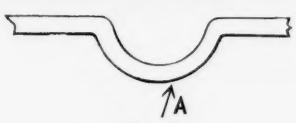


Fig. 3.

hole drilled just where it turns from the horizontal to the vertical, so that water cannot trickle into the fitting, as at B (fig. 4). The above is, of course, assuming that bends are unavoidable.

Drawing Through.—This should be done very carefully, all the wires being paid in symmetrically. One man should hold the wires just where they enter the pipe, and another should pull them out slowly, and not in jerks. French chalk should be freely used for paying in, to reduce friction, and

Fig. 4.

every precaution must be taken to use no force. When the pipes are first fixed a "trail wire," say of No. 16 B.W.G. iron, should be left between every two boxes. In order to connect the trail wire to the insulated wires, pare all the ends for about 3 inches, then twist the strands together round the trail wire, covering the whole with black tape, so as to leave the surface smooth. If such a thing should happen that the trail wire should break, or the fitter has forgotten to leave a wire in the pipe, and it is impossible to get the wire right through from one end—it then becomes necessary to "fish." A wire is twisted up at one end like a large corkscrew, and this is pushed into the pipe; another wire has its end twisted in the form of a hook, and this is pushed in to meet the other wire. By judicious manœuvreing it is not long before the hook catches the corkscrew, and then one of the operators pulls the wire right through.

Caulking.—All joints of pipes, lids of boxes, &c., should be caulked when finally closed, so as to render them as tight as possible. Lids of boxes should be kept screwed down, and when finally closed, the screws should each have a piece of tallow smeared on the thread.

Cleaning Pipes.—Every precaution should be taken before drawing wires in to get every foreign substance out of the pipes, and afterwards always to keep the lids of boxes closed. A large pair of bellows may be used for blowing through the pipes. All oil should be wiped from screwed ends.

Insulation.—This is very important, especially as the pipes run into the wood fixings. The latter should, therefore, be well soaked in shellac, paraffin-wax, or other insulating substances. The same applies to all pateræ and fixings for fuseboards, &c. All marble slabs should have the holes for fixing screws bushed with ebonite, and all lampholders for fixed fittings should have ebonite nipples.

Wire.—Only the highest grade of wire should be used, preferably not braided.

These are the main points to be observed in laying down such an installation. It can only be repeated that the whole plan should be well thought out before, especially in the case of large blocks of buildings, and preferably with the architect, because then all the runs and other details will be approved of, and the clerk of works will support the architect's instructions. For otherwise it will be found that many little interferences make big alterations.

It would, I think, only be fair to add that it was due to the efforts of Messrs. Handcock & Dykes that this system was first successfully adapted to the wiring of buildings some few years back, and that, in the face of a great many difficulties—practical and otherwise—they have succeeded in perfecting it; and there is no doubt that other systems must in time give place to the pipe system, until the time comes when a solid system of copper wires can be run in conduits without leakage, or the walls of our rooms are papered with tinfoil. In the meantime there is plenty of room to improve what has already been done.

"THE ENGINEER" AND TRAMWAY TRACTION.

[Communicated.]

Considered generally to be the leading journal for engineers —perhaps by reason of its venerable age—your contemporary, the *Engineer*, every now and then justifies its position and astonishes the reader by remarkably well-written up-to-date articles upon topics of interest, and the subject now under notice offers an instance of the kind.

Based on that report "de luxe" of the Sheffield Corporation upon tramway traction methods, your contemporary publishes in its last issue a page and a half of tardy but highly sensible remarks dealing with the whole subject in a comprehensive way, and winding up by means of a sentence which will naturally please all electrical engineers, and encourage that section of them devoted to traction work. "Were we in the habit of hazarding conjectures," says the *Engineer* (which reminds me of Mr. Gladstone's "If I were a betting man"), "we should be inclined to suggest that electricity will eventually play the same *rôle* as a tramway motor as it has already successfully filled as a luminary."

Electricity is hardly a luminary, and the construction of this sentence is not so brilliant as its commonsense and hopefulness; but the latter being of more importance than correct orthography or expression, I will leave it to others to quarrel with sounds so long as the sense is right.

There are points, however, in the *Engineer's* article which are worth commenting upon in these columns, for even the *doyen* of journals may not attain perfection of knowledge or experience.

One important item to be criticised is the confusion which seems to exist in the mind of the writer of the article with respect to cable and funicular tramways; the two examples mentioned — Belleville and Edinburgh — both fall into the former class: whilst the Bellevue line (in another suburb of Paris) may fairly be called a funicular railway. Funicular lines as a rule are not street tramways but railway lifts, built on their own right of way, and more often than not combined with a rack rail for safety in working. If I remember rightly the Bellevue line is one of this latter character; the Edinburgh lines on the

other hand are distinctly street tramways, and in company with the Birmingham, Highgate Hill, Brixton Hill, and other lines, are very useful instances of a mode of traction possessing very great advantages under certain conditions, even in comparison with the trolley wire.

It seems to me a great mistake for electrical engineers to advocate the trolley wire everywhere and under all conditions; take a case like Halifax for instance, where there is hardly a level quarter-mile of street in the town. With frequent traffic, a cable system is undoubtedly the best for places of this type, in spite of heavy capital outlay, and if electricity *must* come in, be it only to get a day load, let it serve to work cables on the steepest grades. Otherwise the motor repairs will pretty nearly balance the extra interest on a cable system capital outlay, and the life of the tramway manager be a constant struggle to keep the cars going. This is by the way, however.

Why the *Engineer* considers the Birmingham cable line to be so highly inferior to those at Edinburgh, I do not quite see; of course, the latter are the newest and best of their kind, but there doesn't seem much point to the following remark:—"The cars (*i.e.*, at Birmingham) cannot be reversed, and the gripper must be slackened to slacken the speed."

This I have always considered to be a failing of all cable lines, whether at Edinburgh, Birmingham, or other places; but perhaps Auld Reekie has got a particular patent of its own, and gets the east wind to blow the cars along against the cable.

The *Engineer* hits off in a few words *the* great defect of gas driven tramcars, viz., the fact that they cannot easily (at present) climb a hill. I hardly think that they will do it either, until this type of motor is made to work expansively instead of with a series of explosions. I have heard more than once that a little gentle persuasion in the shape of a crowbar is required for the gas tramcars already at work when they stop on a grade. And yet these motors have undoubted usefulness, and a large field of employment before them. For street tramways, however, they hardly as yet fill the bill, unless passengers don't object to a little vibration and smell, which cannot be quite avoided in spite of ingenious efforts made to overcome both.

In dealing with electric traction systems on tramways, the *Engineer* reaches very sensible conclusions, but on the way thither it discusses matters sometimes in a way that will tickle the initiated. Thus, for example, it divides electric traction methods into five systems:—1. Trolley principle. 2. *Subterranean current* (whatever that may mean!) 3. Conduction boxes with their upper surface placed *à fleur de terre* (translate this "on the ground floor") presumably the Westinghouse or other closed conduit system. 4. Combination of electricity and compressed air!!—doubtless the Popp-Conti system (Popp representing the compressed air, of course; but there isn't much apparent connection between Conti and electricity). I have not yet heard of any line being successfully at work on this system.

The fifth and last class of electric traction methods includes accumulator cars, in regard to which the *Engineer* takes up a very sensible standpoint: they are certainly not suitable for the Sheffield lines, or, indeed, any tramway at all in their present stage of undevelopment.

The cost of conduit systems is almost prohibitive, averaging at about £11,000 per mile, according to the *Engineer*—a sum not far from the truth for new lines. The average cost of the overhead system is stated to be about £3,500 per mile, Rouen boasting of the least, viz., £1,620 per mile, and Blackpool, the maximum, at £5,410.

The value of these latter figures may be taken at an average of a round O, in their present form. What do they, or do they not, include? Overhead construction alone can be done for much less than £1,620 per mile; as a matter of fact it has been stated that 20 miles of single track overhead construction were equipped at Rouen for £33,000, which sum also included all the double rail bonding. However, the *Engineer* is perfectly wise and right in saying that the overhead trolley system was the best for adoption in Sheffield (plus a possible use of the cable on some part of the routes), and, indeed it appears to plunge boldly into the decisive conclusion that these three systems—trolley, gas, and accumulator—are the only ones worth elaborating at the present time in order to get systems as perfect as possible.

Taken all round, the article thus commented upon is an embodiment of sound common sense, and, amongst other places, may penetrate, with advantage, into Birmingham for the municipality to ponder over, now that the question of converting the horse and steam lines requires final settlement.

THE INSTITUTION OF CIVIL ENGINEERS' CONFERENCE.

THE following are the arrangements, directly interesting to electrical men, in connection with the Conference which will be held next week at Westminster Town Hall and the Guildhall, on Tuesday, Wednesday, and Thursday next week. On Tuesday, at 10.30 a.m., Mr. J. Wolfe Barry, C.B., &c., the president, will deliver a short address to all the sections in the Large Hall of the Westminster Town Hall. The discussions on the various subjects will be opened as follows:—

TUESDAY, MAY 25TH.

10.45 a.m.—In the Large Hall, Westminster Town Hall.

Sections III. and VII.—Machinery, &c., and Applications of Electricity.

1. "The Transmission of Power by Electricity." Introduced by Mr. W. H. Preece, C.B., F.R.S.
2. "The Transmission of Power by Water." Introduced by Mr. E. B. Ellington.
3. "The Transmission of Power by other Agents." Introduced by Dr. John Hopkinson, F.R.S.

WEDNESDAY, MAY 26TH.

10.30 a.m.—In the Large Hall, Westminster Town Hall.

Section III.—Machinery and Transmission of Power.

1. "Important Questions in the Economic Working of Steam Engines and Boilers." Introduced by Mr. Bryan Donkin.
2. "Separate Condensing Plants." Introduced by Mr. Henry Davey.
3. "Petroleum as Steam Engine Fuel." Introduced by Mr. John A. F. Aspinall.

" In the Council Chamber, Westminster Town Hall.

Section VII.—Application of Electricity.

1. "Should Generating Plant be mounted on Springs?" Introduced by Mr. James Swinburne.
2. "Turbines applied to Dynamos." Introduced by the Hon. C. A. Parsons.

" In the Committee Room, Guildhall.

Section IV.—Mining and Metallurgy.

1. "Some points relating to the Appliances used by Metallurgists." Introduced by Prof. W. C. Roberts-Austen, F.R.S.

12.0 noon.—In the Large Hall, Westminster Town Hall.

Section I.—Railways.

1. "The Location and Cost of Working of Pioneer Railways." Introduced by Mr. R. Elliott Cooper.
2. "What is true or false Economy in Light Railway Construction?" Introduced by Mr. A. C. Pain.

THURSDAY, MAY 27TH.

10.30 a.m.—In the Large Hall, Westminster Town Hall.

Section III.—Machinery and Transmission of Power.

"Ball- and Roller-Bearings." Introduced by Mr. W. Bayley Marshall.

12.0 noon.—In the Large Hall, Westminster Town Hall.

Section VII.—Applications of Electricity.

1. "The Decimal System in Engineering Measurement." Introduced by Capt. H. Riall Sankey, late R.E.
2. "The Equilibrium System of feeding Electric Railways." Introduced by Mr. C. E. P. D. Spagnoletti.

PARTICULARS OF VISITS TO WORKS.

TUESDAY, MAY 25TH.

A.—3.30 p.m.—Bankside Station of the City of London Electric Lighting Company.

B.—3.30 p.m.—Central London Railway Works, Oxford Circus.

WEDNESDAY, MAY 26TH.

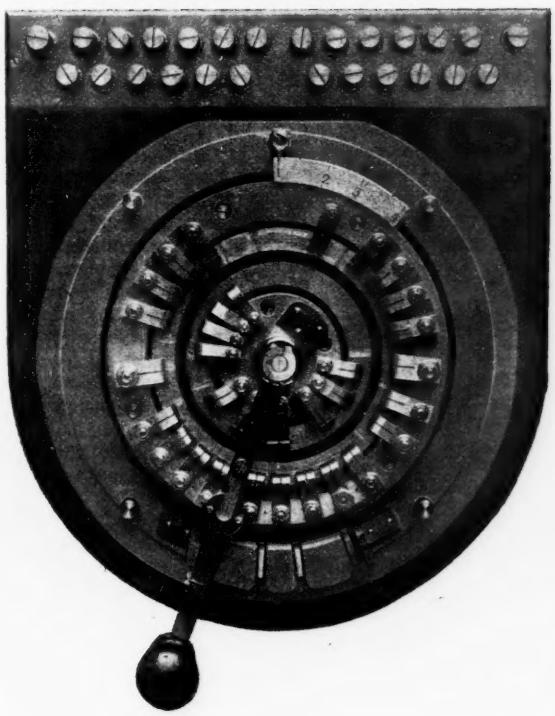
E.—3.0 p.m.—Waterloo and City Railway Works, Upper Ground Street, S.E.

THURSDAY, MAY 27TH.

C.—3.0 p.m.—Messrs. Siemens & Co.'s Works, Charlton. Train, Charing Cross Station, for Charlton, 2.20 p.m. Return trains from Charlton, 5.11, 5.28, 5.51.

PATENT CIRCUIT CHANGING SWITCH.

Mr. Thomas J. Rorke, of 17, Great George Street, has devised a circuit-changing switch which possesses some interesting features. In the switch illustrated, the wires from the lamps are ultimately connected across the concentric segments of brass from the inner to the outer circles. These two sets of brass segments are shown situate beneath two sets of laminated bridging pieces (shown held in position by small nuts). No wires are connected to these two concentric sets of bridging pieces which are fixed upon a slate base (the only moving part of the switch), and large slots in this slate base enable the brass segments to be fixed in position and also enable the inner and outer bridging pieces to be upon one and the same slate base, which is moved to its various positions by the handle; this handle itself constitutes a main switch and it is impossible to move the bridging pieces without first opening this switch, thus no movement of the bridging pieces can take place unless the current is off, the movement from point to point being momentary.



The bridging pieces are intended to open and close the gaps between the brass segments for the purpose of grouping the lamps in various manners for altering the brilliancy, the chief point being the different lengths of segments and bridging pieces.

The mains are connected through the large terminals shown, to particular brass segments on the inner and outer rings.

The contacts of all the bridging pieces are adjusted by a nut in centre and a locking nut. The best effects of the switch are obtained when using 33 volt lamps on a 100-volt circuit, the switch being able to instantly change the circuits from 12 in series to all in parallel, passing through five stages or passing from one position to any other, neglecting the intermediate positions. The switch is not only applicable for one mass of lamps, such as one chandelier, but for controlling the brilliancy of a scattered number of points with an equal number of lamps at each point, as in the auditorium of a theatre, &c., and in this case the wiring would be no more expensive, as the switch would be looked upon as a double pole distributing board to which all circuits would run. The switch is also applicable for the grouping of a number of motors in various stages from series to parallel.

The switch is not applicable for battery work, as the connections are reversed in some of the positions.

A smaller number of terminals might have been used on the top of the switch (17 instead of 24) but 24 have been used to obviate the complications in wiring on external circuit and connecting up.

In wiring for and connecting up the switch, all groups of lamps are wired in parallel, the wires are brought to the terminals in pairs and a mistake is extremely improbable. The whole of the vital parts of the switch are composed of slate, brass and mica.

The following figures show the saving of current when the regulating switch is used as compared with the use of resistance :—

Amount of Current Taken by 24 16-C.P. 33 Volt Lamps.

With Regulating Switch.	amps.	With Resistance Coils.	amps.
1st Position	2·90	1st Position	5 8
2nd do	6 75	2nd do.	9 0
Fully brilliant	12 00	Fully brilliant	12 0

Of course the current depends upon the watts per candle, but this does not affect the above average.

THE HANOVER ELECTRIC TRAMWAYS.

A report on this system, referred to a fortnight ago in the Electrical Review, p. 645, is published in the *Elektrotechnische Zeitschrift*, Vol. 18, p. 178. The tests were made by Herr F. Ross, with the assistance of Prof. Heim, of the Technical High School, Hanover, and Herr Volkers, engineer, of the Union Elektricitäts Gesellschaft. The company offered every facility for testing all branches of their system, and the examination of their books.

In the summer of 1895 the Hanover Electric Tramway Company, who previously had only applied the overhead system to a few suburban lines, had to consider the question of extending their system into the city. The municipal authorities having absolutely refused to allow the overhead conductor in the centre of the city, there was nothing left for the company but to adopt a conduit system, or use accumulators. Their first intention was to introduce the usual system of accumulator traction with stationary charging at the end stations; but, before finally deciding, their energetic director, Herr Krüger, determined to try the experiment of charging the accumulators during the journey from the overhead conductor, and the first experimental car was started running in September, 1895. As is the case with the introduction of every new invention, many difficulties had to be overcome; as a matter of fact, most of the apparatus required had to be specially designed and made. The results obtained with the first car were, however, so successful, that the directors decided to introduce the mixed system of working on a larger scale.

At the beginning of this year, there was about 12·8 miles of track with the overhead conductor, and 10·6 miles worked by accumulators. The charging of the batteries is always done during the journey, over distances, which, owing to local conditions, vary from 1·7 miles to 4·8 miles; the discharging takes place over distances varying from 3 miles to 7·2 miles.

At the power station at Glocksee there are four steam engines, each with a 150-kilowatt dynamo by Siemens and Halske, and corresponding water tube boilers. Three of these machines amply suffice to supply the present demand. The part of the track on the overhead system is fitted with the Siemens & Halske hoop contact, and is in no way different from other lines of the same kind. The cars, for the combined system, have two longitudinal seats capable of accommodating 20 passengers, and under these seats are placed 208 accumulators in vulcanite boxes. The total weight of the batteries amounts in round numbers to 2½ tons.

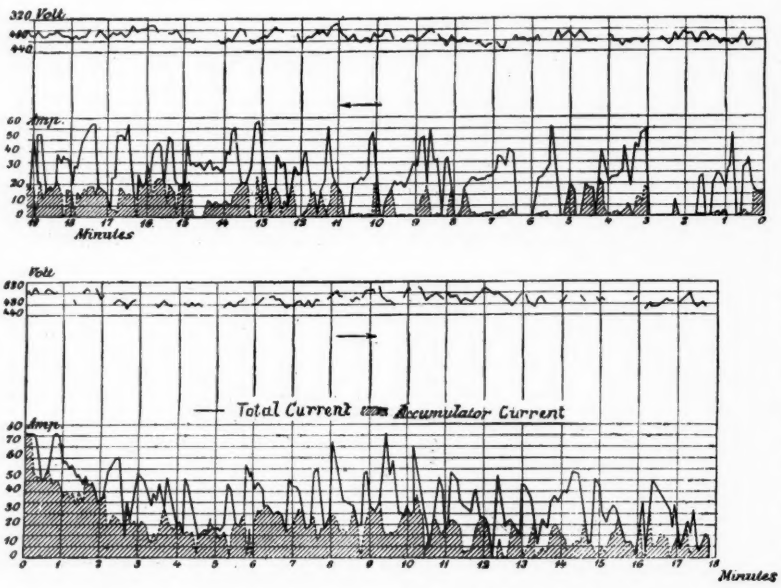
On the platform is a lever switch with two positions, "charging" and "discharging," and also a regulator designed by Herr Adam, engineer, and constructed by Voigt and Hœffner. This regulator fulfils all the requirements

of the mixed system of working in the most satisfactory manner.

During the run on the trolley track the Siemens series motor is regulated by intercalating resistances in the usual way.

The regulator has, besides the zero position, six contacts. Of these, only the contacts 1 to 5 are used on the trolley track; 1 to 4 giving decreasing resistances, while in the position 5 the motor runs without added resistance. When the accumulators are switched on, the battery is first applied in halves arranged in parallel, then the current is successively passed through the decreasing resistances 1 to 4, till the position 5 of no additional resistance is reached. Finally, in the position 6, the two halves of the battery are arranged in series (as when they are being charged), and the motor receives the full pressure of the battery.

In order to find out the consumption of current by the car, a number of experimental runs were made with a car whose battery had already supplied current for a run of 11,000 car kilometres (6,214 car miles). In carrying out these experimental runs, readings of current and pressure were taken every 5 seconds by a Weston meter, and the instantaneous velocity of the car was taken by means of a tachymeter on the car. Simultaneous notes were taken of the position of the regulator and the position of the car on the track by means of the numbered trolley poles. The consumption of energy in watts was obtained by a Thomson wattmeter. All the instruments used were tested after the experiments, by Prof. Heim in his laboratory.



For estimating the consumption of current, a section of the line was selected where there was little traffic in the morning, to avoid the disturbing influence of vehicles, on the experimental data. The section in question was 2½ miles in length, with comparatively few curves, and had two gradients of about 2 in 100. The first experiment was made with an empty car having only the seven persons on board, required for the observations; and then the car was loaded with 2·35 tons to make up the weight of the battery. In all cases the run was made without stoppages, and, as far as possible, the regulator was kept in position 6, that is, without intercalated resistance.

The average power required for the unloaded car was 795 watts per car mile, with an average speed of 13·4 feet per second (9·15 miles per hour); for the loaded car 795 watts per car mile is required with an average speed of 12·9 feet per second (8·15 miles per hour). The effect of the considerable additional load shows itself in a reduction of speed. When all the stoppages were made on the same section, it was found that about 900 watts per car mile was required. A higher value was, of course, obtained in this case, because a certain amount of power is always dissipated by the brake, even with the most skilful driver.

Since it was desirable that the condition of the track should be taken into account, a method worked out by Herr Volkers was employed for this purpose. This method may be explained as follows:—If a mass is placed upon an inclined plane, it experiences an acceleration

$$A_1 = (\sin \alpha - f \cos \alpha)\, g,$$

where A_1 is the acceleration in metres per second, α the angle of the gradient, f the coefficient of friction, and g the acceleration due to gravity. In the case where the car is running up the gradient, there is a retardation

$$A_2 = (\sin \alpha + f \cos \alpha)\, g.$$

From these two equations we get the coefficient of friction

$$f = \frac{A_2 - A_1}{2\, g \cos \alpha}.$$

If the tests are always carried out on gradients less than 2 in 100, the error will be less than 3 per cent. when we take $g = 10$, and $\cos \alpha = 1$; the formula may, therefore, be expressed with sufficient accuracy as

$$f = \frac{A_2 - A_1}{20}.$$

With the help of this formula, the coefficient of friction per 1,000 kilogrammes may be obtained in the following way. Two distances are marked off on the section of the track to be tested, preferably by means of the trolley poles; a suitable acceleration is given to the car by means of the motor, the current being shut off just before the measured section is reached; and the retardation which takes place on the measured section is measured by a stop watch. The experiment is then repeated in the opposite direction. From the values A_2 and A_1 thus obtained, the value of f can be worked out. If a retardation is obtained in both cases the sign of A_1 must be changed.

The value of f found, includes all resistances to the motion of the car, such as air resistance, bearing friction, and force required to keep the motor running without load. The value of f obtained in Hanover amounted in round numbers to 4·8 kg. at a speed of 13·7 feet per second.

The expenditure on the motor running without load would be about 3·7 kg. per 1,000 kg. of weight, so that according to this the traction resistance referred to the axis of the motor would amount to about 8·5 kg.

The traction resistance can also be obtained by measuring the electric energy supplied to the car to maintain a uniform speed on a level section of the track. Experiments made in this way gave with a speed of 17·2 feet per second, a resistance of 11 kg. It is evident, from the comparison of the two results obtained at different velocities, that the air resistance must increase very considerably with the velocity.

By similar experiments, the work expended on the accumulator section was estimated; but in this case all the usual stoppages were made. A mean value of 610 watts per car mile was obtained when the speed was 8·5 feet per second (including stoppages).

The smaller expenditure of energy with accumulator traction is partly due to the lower velocity, but principally to the essentially better efficiency of the arrangement.

In one experiment made, the charging of the batteries extended over a stretch of 4,070 m. of track, while the discharge covered only 2,860 m. The figure shows the progress of the charging of the accumulators during an out and return journey. The area inclosed by the upper irregular line indicates the total quantity of electricity supplied by the overhead conductor, while the shaded portion of this area shows how much is stored up in the accumulators.

As a mean value from eight charging and discharging runs

the efficiency of the battery came out in round numbers at 74 per cent. But as this was obtained under very favourable conditions, it would be well in practice not to reckon on more than 70 per cent.

There is great danger of wasting energy by over-charging the battery; it is expected that an apparatus for sounding a bell when the battery is charged will soon be brought out, since preliminary experiments have already shown that this apparatus works very satisfactorily.

Since there is not sufficient pressure at all parts of the trolley wire to charge the battery, a small supplemental charge is given after the car has returned to the shed.

In connection with the experimental runs, a number of capacity tests were undertaken.

At that time, two kinds of elements were in use in Hanover; in the older cars, the nominal capacity was 20 ampere-hours, and the time of discharge 1 hour; while in the newer cars, plates of 25 ampere-hours capacity were used. The weight of both plates is almost exactly the same, the only difference is in the extent of the surface and the method of formation. As the result of six capacity tests with batteries of the older type, it was found that the discharge current varied between 20 and 25 amperes. These tests were made on batteries charged on the line, and also on some that had received an additional charge at the station. It was not possible to ascertain whether the capacity of the battery was maintained after having been in use for a considerable time, a course of experiments has, however, been undertaken to test this point. In ordinary working, only about 25 per cent. of the maximum capacity is used, it being necessary to have a suitable reserve for occasions in which the road is obstructed with snow and ice.

Brake experiments were made to test the efficiency of the motor and reducing gear. This was found to be by no means high, varying from 53·7 per cent. with 504 volts to 65·2 per cent. with 348 volts. The better efficiency with lower voltage is supposed to be due to the fact that there is less loss due to the toothed gearing.

These experiments explained why there was little difference in the power consumed by the loaded and the unloaded car. The reason evidently is, that the efficiency of the motor increases at a much faster rate than that of the current supplied to the motor. It is further to be noted that many of the losses, such as that due to the resistance of the air, are independent of the weight of the car. The increased loss is therefore by no means proportional to the increased weight.

The fact that the efficiency of the motor is rather higher when the lower pressure of the accumulators is employed is in favour of this system; and also the fact that there is less loss in regulating the speed by the parallel series arrangement of the battery than by introducing resistances which would otherwise be a necessity with the single motor cars used in Hanover.

from this table that as the accumulator kilometres increased from 8½ to 44½ per cent. of the total output, the watts produced per kilogramme of coal rose from 321 to 480.

The decrease in the last two months is only apparent, and is due to the increase of consumption of electric power and light in the workshops. The increased efficiency of the fuel is no doubt partly due to the extension of the system, but is mainly due to the favourable influence of the batteries in equalising the load. The consumption of watts per train kilometre increases from 527 to 637, but this is due to the circumstance that larger cars were introduced in the later part of the year.

While the watts consumed per train kilometre in Hanover is somewhat greater than with some overhead lines, the coal consumption is quite as favourable. The better training of the motor men, and the introduction of the new regulator, promises to greatly increase the efficiency of the system.

It only remains, now, to estimate the cost of maintenance and attendance for the batteries. This has been found from an experience extending over several months to amount to 1·31 pfennig (·157 pence) per accumulator kilometre.

From the above data, Herr Ross considers he is justified in drawing the following conclusions:—Taking 10 per cent. as the rate for interest and depreciation, and adding the cost of attendance and maintenance, the cost works out as 2½ pf. (·3d.) per car kilometre. Taking also into account the increased cost due to renewals and greater consumption of current, and allowing for the better utilisation of the central station, the total cost per car kilometre rises to 5 pf. (·6d.) per car kilometre.

A comparison is then made with the estimated cost of a conduit system to replace the accumulator system. He finds that for interest and depreciation alone, with the conduit system, the cost per car kilometre would amount to 22 pf. (2·6d.), which, he remarks, would make electric traction impossible.

Comparing, now, the Hanover mixed system with a system in which the overhead conductor is used throughout, he finds that interest and depreciation in the latter case will amount to 3 pf. (·36d.) per car kilometre. Subtracting this amount from the cost of the accumulator working, the difference is only 2 pf. (·24d.) per car kilometre; and if the cost is distributed over the total car kilometres supplied, the difference is less than 1 pf. (·12d.).

No marked effect on the wear of the rails, owing to the greater weight of the cars, has been observed in Hanover.

The accumulator system is in several respects superior to the conduit system, for general convenience in working. For example, when the line is displaced by street repairs, it causes little inconvenience with the accumulator car, but, as is well known, this is by no means the case where the conduit has to be moved.

As a storage reservoir of power, the battery frequently renders important service. On one occasion, in Hanover,

General View of the Results of the Working, 1896.

Month.	Kilowatt-hours.	Total train kilometres (cars hooked on reckoned as half.)	Accumulator car kilometres.	Accumulator car kilometres. Per cent.	Total consumption of coal, inclusive of heating, lighting, and driving workshops. Kilogrammes.	Watts per kilogramme of coal.	Coal per train kilometre.	Watts per train kilometre.
January	58,590	111,139	9,618	8·6	182,741	321	1·644	527
February	55,337	103,739	8,877	8·5	170,262	325	1·641	533
March	61,633	112,462	9,567	8·5	179,843	348	1 598	548
April	83,326	146,106	27,459	18·8	205,106	406	1·404	570
May	106,765	174,241	43,564	25·0	239,537	446	1·375	612
June	100,033	166,447	40,947	24·6	211,043	474	1·282	609
July	107,970	179,621	50,173	27·9	230,393	469	1 225	601
August	116,856	196,651	58,106	29·5	241,439	484	1·225	594
September	129,989	216,194	65,921	29·2	269,794	482	1·248	601
October	136,821	226,172	75,416	33·3	284,227	481	1·257	605
November	161,941	254,501	106,077	41·7	347,475	460	1·365	632
December	176,949	277,750	123,880	44·6	384,777	459	1·380	637

The use of accumulators on the cars was found to exercise a very favourable influence on the utilisation of the machinery at the central station. They acted, in fact, as equalising batteries, and greatly reduced the variations of the load.

The table brings together the essential factors of the working of the station for each month during 1896. It is evident

during a breakdown in a feeder cable, it was possible during the repair to keep the cars running on the section affected, by the accumulators alone.

It is admitted that the conduit system may be cheaper for a short break in a large network, but it is considered that for similar conditions to those existing in Hanover the accumu-

lator system is far superior. The introduction of the mixed system in Hanover must therefore be looked upon as an important step in electric traction, and offers a satisfactory solution of problems which arise in the application of electricity to street tramway working in all great cities.

PHYSICAL SOCIETY.

Ordinary Meeting, May 14th, 1897.
(Mr. Shelford Bidwell, President, in the Chair.)

Prof. Carey Foster read a paper by Mr. D. K. Morris, of Zurich, on The Effect of Temperature upon the Magnetic and Electric Properties of Iron.

The investigation relates to the measurement of the magnetic permeability, hysteresis, and electrical resistance of iron, simultaneously at different temperatures. The specimens are formed into annular rings, made from iron strip. The strip is first lapped round with asbestos paper and mica, and then wound upon itself to the required thickness. A platinum wire is included in the mica lappings, for thermometrical purposes. Upon each annular ring are the following windings:—(1) A primary magnetising coil; (2) A secondary coil connected to a ballistic galvanometer; (3) An electrical heating coil. Further, the iron strip is itself connected to a Wheatstone's bridge, for resistance measurements. The coil can be heated to 1,050° C. At the higher temperatures the surrounding air has to be freed from oxygen; this is done by enclosing the coil in a suitable vessel and exhausting with an air pump; when most of the air has thus been removed, the residual oxygen is absorbed by an electrically-heated iron wire. Curves are drawn representing the changes of permeability at the different temperatures; and, at the same temperatures, the corresponding hysteresis loops are plotted. The hysteresis diminishes with temperature; it nearly vanishes at about 764° C. At the suggestion of Prof. Ayrton, it was agreed that the discussion on this paper should be adjourned until the publication of the results. The paper will, therefore, be printed without delay:

Mr. Rollo Appleyard read a paper on The Formation of Mercury Films by an Electrical Process.

If a sheet of damp leather, or similar permeable substance, is used as a separating diaphragm between two bodies of mercury, and a current is sent through it, a film of mercury is deposited upon the surface connected to the positive pole; and the film remains on the diaphragm after removal from the apparatus. If the diaphragm is replaced in the apparatus, and subjected to a current in the reverse direction, the film vanishes from that surface, and a second film appears on the other side. That is to say, the film is always on the side of the diaphragm connected to the positive pole of the battery, and there is no film on the negative surface. Different diaphragms and films were exhibited, of filter paper, asbestos paper, plaster of Paris, &c. A current of about $\frac{1}{50}$th of an ampere, or more, is necessary. A sheet of tinfoil included between folds of filter paper becomes perforated with pin holes when the current is passed between the outside surfaces. This happens whether the outside electrodes are mercury or metal plates. If the top electrode should be tinfoil, this also becomes perforated as well as the included sheet. A further experiment was shown in which a gold coin is placed upon the folds of filter paper; the current produces a gold discoloration which penetrates the folds. This, it was suggested by the author, may help to account for the formation of metallic lodes and veins as they exist in rocks; and they may partly explain the "inductoscripts" of Mr. F. J. Smith.

Dr. S. P. Thompson said he did not know of any other example of an *anode* being more active, mechanically, than the *cathode*, except the electric arc. He was surprised that the film should appear on the positive surface.

Mr. Shelford Bidwell thought selenium presented, in some of its actions, an example of the *anode* being thus active.

Prof. Ayrton said that if a vessel containing a substratum of mercury amalgam was filled up with water in which gold crushings were washed, the gold descended into the amalgam. This, however, might be due partly to gravity, and partly to simple electrolysis.

Mr. Appleyard said he had no definite views as to the formation of the films. He believed it to be a secondary effect of electrolysis, aided by electric osmosis. The experiments of Mr. C. K. Falkenstein upon the electric tanning of leather, and the early results of M. Perret, helped the idea of electric osmosis, they were not sufficient, however, to justify that theory, without further research. A careful chemical analysis of the deposits left in the folds of filter paper would be the best guide.

THE SOCIÉTÉ INTERNATIONALE DES ELECTRICIENS.

The sitting opened May 5th at 8.30 with Dr. d'Arsonval in the chair, he having been appointed president at the last sitting. Some new members were admitted, and then the general secretary read the report of the work submitted to the society.

Dr. d'Arsonval in a very modest speech thanked the society for the honour conferred upon him. He said that he was neither a scientific man nor an engineer, but that he had been connected with the Society since its foundation. He then spoke of laboratory and workshop experiments, and thanked his predecessor.

M. Lasnier then read a paper on the system of electrical traction which is used on the lines from the Madeleine to Courbevoie, Neuilly and Levallois. This system has been in service for the last month, and comprises three lines, one from the Madeleine to Courbevoie and Neuilly (6·7 kilometres), the second from the Madeleine to Courbevoie (6·6 kilometres), and the third from the Madeleine to Levallois. The system of traction used is by accumulators, with charging stations at the extremities of the lines; the charge is very rapid, being effected in a few minutes. The generating station contains three Babcock and Wilcox boilers, giving 1,800 kg. of steam per hour at 16 kilogrammes per square centimetre, three Willans steam engines of 200 H.P. at 460 revolutions a minute, each driving directly a Brown 4-pole dynamo of 200 amperes and 660 volts.

The distribution board is divided into three distinct parts, each part relating to one engine. Each division comprises the fusible circuit breakers, a bi-polar interrupter, a Hartmann and Braun amperemeter, and an excitation rheostat.

The feeders taken from the terminals of the board are five in number, two being used for the charging at the depôt and the lighting, and three for the lines at the termini. The charging stations are at the extremities of the lines, of which we have already spoken. The two first have a section of 150 square millimetres, and the third a section of 250 square millimetres. At the starting point of each line on the distribution board are a lever interrupter and an automatic interrupter serving as disconnectors, and also circuit breakers and an ampere meter. At the various charging stations is a terminal which includes a board containing a circuit breaker, an interrupter, and an apparatus giving notice of the end of the charge. At the moment it stops, the driver has only to put the wires of the car into communication with the wires of the charging station and to wait for the bell to ring. The end of the charge is then announced.

The cars are very comfortable. They seat 52 persons. The Tudor accumulators, 200 in number, weighing altogether 3,600 kilogrammes, are placed under the seats. The cars themselves were constructed by the firm of David and Desouches. The electromotors are two in number, of 25 H.P. each, and have four poles with carbon brushes. A special controlling apparatus enables all the necessary operations to be effected for starting or stopping the car. On each car are little ventilators for letting out the gases given off by the accumulators. The results obtained have up to the present been very satisfactory, the maintenance of the accumulators has been almost *nil*, the cars have made journeys of 6,000 kilometres. The expenditure has been estimated at 860 watt-hours per car-kilometre, and at 2 591 kg. of coal per car-kilometre. The electrical efficiency of the accumulators amounted to 71 per cent.

M. E. Hospitalier then read a paper on electric motor cars. First he reminded his hearers that in 1881 he expressed the opinion that accumulators would be improved and would be rendered suitable for electric cabs. This prediction is already partly fulfilled and it is probable that in a year's time electric cabs will be running. He then discussed the powers attributed to the horse. This power is variable; it may, however, be estimated that a horse can produce 500 watts and 3 kilowatt hours per day. If this power and this energy is expressed by weight, we get only 1 watt per kilogramme and 6 watt hours per kilogramme. These figures are certainly below those given by an accumulator. In the case of the horse, the rein is sufficient for its guidance, it can produce at each pull a traction effort of 100 kg. Its speed is very variable.

As regards electric motor cars we can only depend upon accumulators with a motor and controlling apparatus. These cars are supplied with all the modern improvements—the jointed axle, ball bearings, and the pneumatic tyre. With regard to the latter point M. Hospitalier referred to M. Michelin's recent experiments and showed the advantages of the pneumatic tyre.

Accumulators have now made great progress. In 1881, we reckoned ·6 watt per kg.; a few years later we obtained 2 watts per kg. and 12 watt hours per kg. In 1897 the Fulmen accumulators furnish 30 watt hours at the output of 1·5 watt per kg., 25 watt hours at the output of 5 watts per kg., and 20 watt hours at the output of 10 watts per kg. As regards the duration of accumulators, special experiments would have to be made. But briefly, we may say that in 1881, 1,000 kg. of accumulators were required to produce 1 kilowatt, and 100 kg. to produce 1 kilowatt hour; in 1897, 200 kg. are required to produce 1 kilowatt and 50 kg. to produce 1 kilowatt hour.

Electromotors have also made very great progress. In 1881 their efficiency was barely 60 per cent., and their weight from 30 to 40 kg. per kilowatt. In 1897, the efficiency amounts to 80 per cent. and their weight is reduced to 15 or 20 kg. per kilowatt. Electromotors have the great advantage of supplying automatically a couple which increases as the speed diminishes; they are self-regulating. This is not the case with the petroleum motors which produce a constant motive couple. The principal advantages of electric motor cars are the following: Safety, absence of jerking and shaking, stoppage of mechanism during stoppages of the vehicle, absence of heat, absence of smell, cleanliness, simplicity of construction, facility in starting and stopping. All the modern cars at the present day present almost equivalent advantages as regards elegance, economy, and inexpensiveness.

The inconveniences attached to electric motor cars are as follows: A charging station is required for the accumulators, the weight of the motor and the accumulator is considerable; in an ordinary vehicle, however, we must take into account the weight of the horse which is no little. The cost is rather high. Objections are also raised against electric motor cars on the ground that acid is used, but this liquid is placed in closed accumulators.

As regards the re-charging of the electric batteries, there are three solutions of the problem.

1. Rapid charging at the station.
2. The replacement of the batteries after discharge.
3. Charging during the night.

Rapid charging at the station would be somewhat difficult, especially if there were many cars. The replacement of the batteries would offer certain difficulties. It seems therefore that charging during the night would be the best way of meeting the case. 44 to 45 elements would be required which would be charged from the distribution lines at 110-1,120 volts. The charging would be almost automatic; ·4 fr. the kilowatt hour would probably be the price asked by the electrical companies. Lastly, various other systems have been proposed for electric motor-cars. Amongst the principal we may mention a proposal to place the whole of the Heilmann system on a car, and the employment of a petroleum engine of low power driving a dynamo for keeping the accumulators charged. Lastly, portable kilowatt-hours can also be used. Boxes giving car kilowatt-hours could be bought. M. E. Hospitalier then briefly reviewed the chief systems of car that have been constructed. In 1881 M. Trouvé constructed an electric tricycle; various cars were brought out by Mr. Ayrton in 1882, by Mr. Magnus Volk in 1887 and 1888, by M. Carli in 1893, by M. Bouchain d'Armentières and by M. Jeantaud in 1894. In 1894 and 1895 various experiments were made in America by M.M. Morris and Salom. In 1897 M. Krieger constructed a car that has already been described. To these various types we may add the Riker car of New York, Darracq's electric hansom, the Ward omnibus of London, &c.

It may be asked what is the energy required for starting? Messrs. Morris and Salom have made several experiments with regard to this point. They found that a car weighing 900 kilogrammes to seat two persons, would expend 83 watt-hours per kilometre-ton at a speed of 8 kilometres per hour, 84 watt-hours per kilometre-ton at a speed of 19 kilometres per hour, and 95 watt-hours per kilometre ton at a speed of 32 kilometres per hour. We must therefore reckon about 100 watt-hours per kilometre-ton. A car weighing 1 ton will contain 400 kg. of accumulators; we can, therefore, obtain runs of 60 kilometres. This would be a very satisfactory length for a journey.

The cost of charging would be about 3 to 4 francs per charge. In fact, in the above case for 8 available kilowatt-hours, the cost of the charge must be estimated at 10 francs. For maintenance and the sinking fund we must reckon 3 francs a day, or about 1,000 francs a year. Altogether, therefore, we must estimate that 60 kilometres a day would cost from 7 to 8 francs a day.

To make a fair comparison, we must take into account such items as forage, diseases of horses, stabling expenses, &c.

In conclusion, M. E. Hospitalier said that electric cars and cabs are on the eve of taking up an important position in practical traction. He hoped that Paris would cease to be an inferno of horses, and would become as soon as possible a paradise of accumobiles.

UTILISATION OF THE ST. LAWRENCE.

The existence of large waterfalls which can be economically developed may in certain conditions prove as valuable as coal fields. These conditions are, either that a waterfall shall exist within reasonable distance of large centres of industry, to which the power can be transmitted with economy electrically, or in the present advancing state of the electro-chemical industry, be located in a district to which the necessary materials can easily be transported for the manufacture electrically of chemical re-agents used on a large scale commercially.

In this country very few water-powers exist that can be described as large powers compared with those found in other parts of the world; and even in Switzerland, where, perhaps, larger water-powers exist than in other parts of Europe, the water-powers are small compared to those to be found on various parts of the American Continent.

Of late, the value of cheaply-developed water-powers has been realised in the United States, and from month to month we hear of these powers being developed and put to useful purposes. The developments at Niagara represent, of course, the largest instance of a single water-power development; but there are many others also in the States of not inconsiderable size that have been put to useful work. For instance, taking those only above 5,000 H.P., there are the following:—

Potomac River, 5,000 H.P.
Macon River, 5,000 H.P.
Weldon River, North Carolina, 10,000 H.P.
Knoxville, 5,000 H.P.
Mechanicsville, 5,000 H.P.
Corral, Hollow Mines, California, 9,000 H.P.
Sacramento, 11,000 H.P.
The Pelzer Manufacturing Company, 7,610 H.P.
Big Cotton Wood Power Company, 6,800 H.P.
Columbia Water Power Company, 5,000 H.P.
Lachine Rapids Hydraulic Company, 12,000 H.P.
Pioneer Electric Power Company, 11,000 H.P.

At the time that the Niagara Works were contemplated and executed, it was thought hardly possible that any power on such a considerable scale could be developed more economically in the United States, and at present this company have, as is well known, a tunnel of sufficient capacity to carry off the tail water from 120,000 water H.P. with an inlet canal of the same dimensions.

Whilst some portion of this power is delivered as water to the Wood Pulp Paper Company, 15,000 H.P. have been delivered electrically, and are being used for the purposes of the electro-chemical industries of various sorts who have established works in the neighbourhood, and a portion is transmitted to the city of Buffalo, 26 miles distant for working electric tramways in that city, and a further amount will ultimately be used for providing a supply for lighting purposes there also. The demand for power has been sufficient to warrant the directors of that company lately to place orders for the extension of their power-house and wheel pit and the purchase of five more generators with their turbines each of 5,000 H.P., making in all a total of 40,000 electrical H.P. development.

The capital spent by the company in reaching this point is in the neighbourhood of nine million dollars.

Rather more than a year ago it was discovered that extraordinarily favourable conditions existed to utilise the waters of the St. Lawrence River in the neighbourhood of the township of Massena. The St. Lawrence flows past the township of Massena at a distance of about 2½ miles from it, and from this point falls rapidly, upward of 56 feet in a distance of 7 miles. A smaller river which takes its rise in the Adirondack Forest, flows through the township of Massena, and joins the St. Lawrence about 7 miles below this township. This is called the Grass River.

The Grass River falls less than 6 feet between the township of Massena and its junction with the St. Lawrence. It therefore follows that the difference of level between the St. Lawrence and the Grass River, in the neighbourhood of the township of Massena, is upwards of 50 feet.

The Grass River, although very small in comparison with the St. Lawrence, would be, in our estimation, of considerable dimensions, being at its narrowest part below Massena about 300 feet in breadth, and bounded by steep banks on each side, enabling an enormous volume of water to be put into it without in any way endangering the surrounding country.

It has been found that a canal can be cut between the St. Lawrence and the Grass Rivers across country, having a length of about 3½ miles. The country between the two streams is practically level at this point, and at this point is fortunately at the same height as the banks of the St. Lawrence until the Grass River is reached, where the country falls over steep bluffs to the level of the St. Lawrence River.

These facts having been ascertained, a Charter was obtained from the New York Legislature empowering a canal to be cut between the two rivers, and the waters utilised for the purposes of power generation; the Charter providing that water might be drawn from the St. Lawrence to any extent that would not interfere with the navigation of that river.

The navigation is limited by the depth of the Cornwall Canal, up which all vessels have to pass in order to avoid the rapids of the St. Lawrence; and the extreme depth of the Cornwall Canal being 14 feet, the draught of all vessels navigating the St. Lawrence above the canal is limited to something less than that.

The minimum depth of the St. Lawrence in the navigable channel at this point is 24 feet, and its maximum depth about 64 feet; it therefore follows that the waters of the St. Lawrence might be tapped to the extent of nearly 10 feet in depth before the navigation could in any way be interfered with, and if the waters so abstracted were diverted to the Grass River, they would be returned to the St. Lawrence further down, thus having no effect on the river in its lower reaches.

The company has been formed for the construction of a canal between the St. Lawrence and the Grass Rivers, and for the utilisation of a large quantity of the power so produced electrically. This canal will be about 220 feet in width along the water surface, and about 26 feet in depth,

and will have a water bearing section of something over 6,000 square feet.

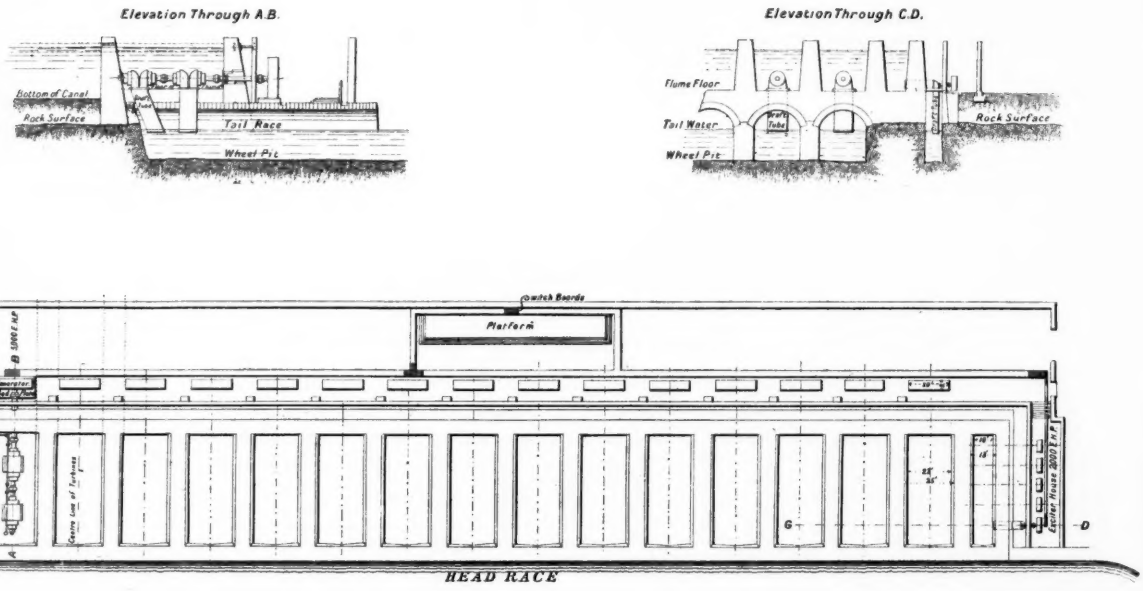
Running at a reasonably slow speed, it will enable a sufficient quantity of water to be put into the Grass River to develop 150,000 H.P. with a working head of 40 feet.

The country between the St. Lawrence and Grass Rivers is almost wholly alluvial soil, comparable to our blue clay, though somewhat looser in its nature. It is therefore extremely easily excavated, whilst on the other hand, it will form an exceedingly reliable bed for the canal.

Borings having been made all along the route of the canal, it has been ascertained that no rock exists along the line of the cutting, but nevertheless a ledge of limestone of an excellent quality outcrops on the banks of the Grass River, and underlies the whole of the country towards the St. Lawrence at a lower depth than the bottom of the canal.

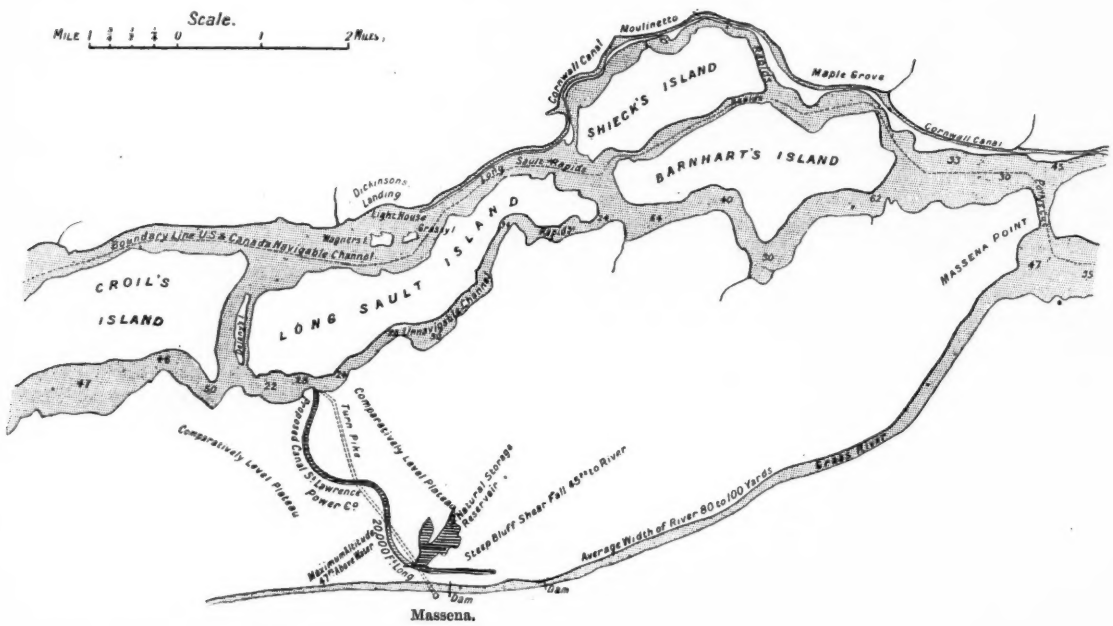
These conditions are quite phenomenal, for whilst ease of excavating the canal with the absence of all rock cutting is ensured, the existence of the level plateau of limestone on the banks of the Grass River, and just above its waters, provides the best of foundations for the construction of the proposed electrical power house.

The company are proposing, whilst making the canal of



Scale 1 inch = 80 feet.

Proposed Arrangement of Turbines and Electrical Machinery, Total 77,000 E.H.P.



Massena.

It is

sufficient dimensions to develop 150,000 H.P., to put down electrical machinery for the production of 75,000 electrical H.P. from this. This power will be developed by the installation of 15 sets of turbines and electrical generators, each having an output of 5,000 E.H.P.

The reasonable height of the fall allows of the turbines and generators being placed on horizontal shafts in place of on vertical ones, as at Niagara, with a consequent simplification of the whole of the engineering problems.

The attached plan shows the manner in which it is proposed to dispose of the turbines and generators, from which it will be seen that the turbine flumes will be separated from the head race by a strong masonry wall with arched entrances into each flume, which entrances will be closed by sluice gates and suitable racks.

The shafts on which each of the two pairs of turbines will be mounted will be continued through the wall of the power house, and be there connected to the 5,000 H.P. electric generators.

It has been decided to use four turbine wheels on each shaft arranged in two pairs in order to obtain a speed of 150 revolutions per minute under the working head of 40 feet, enabling the generators to be made at a reasonable cost, whilst if one pair of turbines of larger diameter were used, the speed would be so low that the generators would be of excessive cost.

These turbines are supported in draught boxes resting on the floor of the turbine flume, and a draught tube will continue the fall to the forebay of the tail race underneath. The head in the turbine flumes will be about 19 feet, whilst the length of the draught tubes to the level of the water in the tail race will be about 21 feet.

The excavation of rock that will be made for the formation of the forebay into the Grass River will provide most of the material required for the masonry walls and arches and superstructure forming the turbine and power-house.

As will be seen from the sketch plan of the power-house, the whole of the machinery employed will be of exceptionally large dimensions, the outside diameters of the generators will approximate to 20 feet, whilst the shafts connecting them with the turbines will be about 22 inches in diameter. The total length of the power-house to accommodate the 15 main generators will be 525 feet in length, whilst the electrical H.P. provided in the exciter annexe for the excitation only of fields of these generators will be 2,000 H.P., not an inconsiderable power station in itself.

The phenomenally favourable conditions of the country referred to above will enable, on the estimates made, the canal for 150,000 H.P., the power house and generator for developing 75,000 E.H.P., to be put down at a cost not exceeding 2½ million dollars, and the electrical H.P. developed for this capital sum will, therefore, be just twice as much as at Niagara, whilst the water H.P. carried by the canal will also be in excess of that developed so far at Niagara.

It is proposed to charge from $12 to $15 per electrical H.P. per annum for 24 hours a day, which is also, probably, the cheapest price at which electrical H.P. has yet been sold.

The engineers for the company are Messrs. Kincaid, Waller & Manville, and Mr. John Bogart, of New York, who was one of the consulting engineers most concerned in the Niagara Falls development.

UNDERGROUND CONDUIT ELECTRIC TRACTION IN NEW YORK.

It is, perhaps, a little to be regretted that the Birmingham Corporation Tramway Committee's report was not delayed for a few weeks, so that the compilers thereof could have been informed that the New York Metropolitan Traction Company were proposing to enormously extend the conduit system at present working on Lennox Avenue.

The American electrical and tramway papers have been very full of the matter for some time past, and illustrations galore of conduit, insulators, manholes, conductors, &c., have appeared in full dimensioned detail.

At first glance, such a matter would appear to fully justify the good Birmingham people in their efforts to keep out the trolley wire; and overhead wire enthusiasts may feel glad, rather than not, that these additional facts could not be introduced into the Committee's report.

Every bane has its antidote, however, and the advocates of trolley wires need go no further than the first manhole to find a very sufficient reason for hesitating at the equipment of more conduit lines.

It is very easy and comparatively harmless for Mr. A. to *recommend* a neighbour, Mr. B., to build his house extravagantly, but where is the equity of *forcing* him to do so merely because Mr. A. likes to look at a pretty house rather than a plain house? Yet this is what the Committee proposes, on the ground, forsooth, of protecting public interests. The public should speak for itself on a matter of this kind.

When we look merely at the manhole designs proposed for the new conduit lines in New York, we feel profoundly grateful that some one else has got to pay for them. Placed every 200 feet apart, they run across the street more than 17 feet in length, 4 feet in width, and are about 5 feet deep. In addition to these concrete pits there are of course, the regular concrete trenches for the conduits themselves, with cast-iron yokes 5 feet apart, everything in fact being constructed on absolutely the best and most perfect cable tramway practice, irrespective of cost.

The outlay will therefore be probably no small amount in excess of anything hitherto attempted for cable working, and we do not mind expressing a belief that the cost will be nearer £20,000 a mile than £15,000.

Now what is the object of spending so much money on an electric road in a place like New York, the leading city in a country where every little village has its trolley road. We cannot help thinking that no small reason for the objection to overhead wires in New York lies in the fact that while in the States the Board of Trade exists not, unless it be as an equivalent for our Chambers of Commerce or Stock and Commercial Exchanges, the Board of Trade with us is a Government office devoted to matters that perhaps belie its name, but which include the proper supervision of overhead electric wires of all sorts.

When the New Yorker has no security from warfare between the trolley wire and telegraph or telephone wires; or between the rails as return conductors and the gas and water pipes supplying him with necessaries, then it is not to be wondered at that he rebels against the trolley and prefers to have a double conductor sunk in the ground.

Although, therefore, on the first glance it might appear that the Birmingham tramway amateurs were supported in their conclusions by evidence from New York itself, yet when the real facts come to be inquired into (as should be done even by a municipal "statesman,") the conditions are so totally different that no comparison whatever can be made, unless it be to show the absurdity of advocating any system off-hand, or the unfairness of thrusting an expensive design (where a cheaper one serves every purpose equally well) upon a tramway company at the hands of those who don't have to pay for what they demand.

CORRESPONDENCE.

American Electric Motor Car Race.

As there appears some little misunderstanding as to the real facts relative to the Providence motor car race, and as we are now in a position to give the actual facts of this interesting affair from particulars supplied to us by Mr. A. L. Riker, the inventor of the "Riker system," we take pleasure in sending you the correct information, so that this matter may be put right at once and for ever.

The Electrical Review was the first technical journal in London to publish the information respecting the above race, and permit us to say that although the report was only in brief, the particulars recorded by you were correctly stated, and, as further information would say that the actual particulars and speeds obtained at the race by the Riker phæton were as follows:

In the first heat the Riker car, with only 40 storage cells, did the 5 miles in 15 minutes and 1 second. In the second heat with the same cells the car did the space in 13 minutes and 6 seconds, and in the third heat the 5 miles were done in 11 minutes and 28 seconds.

We are informed that the Morris-Salom people in the first heat used 49 cells to drive their motor, or a pressure of about 18 per cent. over and above the actual voltage of the motor used by them, which battery power was increased to 55 cells in the second heat, being an increased pressure of E.M.F. of about 30 per cent., and still the Riker car came in with flying colours. The third and final heat was not fairly run, because it is said that the Morris-Salom people increased their battery power to 60 cells, being a pressure of about 40 per cent. over the actual voltage of the motor used by them, and yet with all this extra E.M.F. they only gained 1 second in time. Consequently, with a knowledge of these facts before us, we felt perfectly justified in expressing our opinion that the Riker motor and methods of regulation for motor car work is the best and the most reliable system for electric hansoms, motor cars, and horseless carriage purposes, and with further information obtained, we will go still further and include yacht and boating purposes, as shown by the splendid results obtained from the 25 kilowatt Riker motors used for propelling Mr. Astor's yacht, the *Utopian*, particulars of which were recorded in the REVIEW of April 2nd last.

It may interest your readers to know that we are having constructed at one of the largest carriage builders in London, a specimen parcels van, an electric phæton, and an improved electric cab employing 1½-2 and 3 kilowatt Riker motors, which vehicles will be driven by the new Woodward multipolar traction cell, a combination which we thoroughly believe in, but for the present will leave the merits of both systems for other experts to report upon, which they will be invited to do after the vehicles are finished and ready for working on the thoroughfares of the metropolis, and at the same time, we feel bound to say that both the "Woodward battery and the Riker motor," also the methods of regulation which will be adopted by us are new and entirely fundamental, and so far entirely free from the claims of certain would-be monopolists of the motor car industry.

Shippey Brothers, Limited.
per ARTHUR SHIPPEY.

Lead Poisoning in Accumulator Factories.

The recent fatal case of lead poisoning, which formed the subject of a coroner's inquiry last week, was reported in such a way that the casual observer or reader would probably lay down his journal with an impression that the death occurred through negligence—to use the mildest term—on the part of the employers of the deceased lad. The coroner and the factory inspector both indulged in a little cheap sermonising upon the employment of boys, and also on the enormity of not compelling the workmen to make use of the baths provided for them.

If accumulator manufactories were run upon the same lines and governed by the same rules that obtain in casual wards and convict establishments, the enforcement of the "Order of the Bath" would be a matter of extreme simplicity. But, however, as the men and boys who are thus employed are free individuals, they are at liberty to do as they please, which is to rarely make use of the accommodation provided for them. When the regulations governing the management of lead works were framed, an extraordinary amount of solicitude was exhibited about the employment of women in such establishments. Well, anyone who has practical experience of any length of time at all, will tell you that the weaker (?) sex enjoy far greater immunity from plumbism than do men.

With regard to the liability of boys to be affected, I can only say that during the time I had the control of the accumulator department of Messrs. Johnson & Phillips, where I had from 40 to 50 lads at work, *not one single case of lead poisoning* occurred amongst them. Susceptibility to plumbism is not the same in everyone. Many who suffer have themselves to blame. There is always present the possibility, but with cleanliness and care on the part of the individual workman, the chances are enormously decreased. No one who has had the supervision of a factory where lead is the basis of the work can desire to do otherwise than all in his power to mitigate the ravages of this fearful scourge; but just as it is impossible to make a man moral by Act of Parliament, so is it beyond the power of any employer, manager, or foreman to make a workman clean in his work and habits.

In your columns I have expressed my views before.

I have for years been associated with accumulator-making of both Faure and Planté types, but I have never, in even the slightest degree, been affected, and I know several who have enjoyed similar immunity. On the other hand, the most careful man *may* be attacked, and when such is the case he should not, *when well*, be allowed to resume work again, for a recurrence is sure to occur. These cases, however, are very rare. I am prompted to write thus solely by the hint thrown out at the inquest, that action might be taken against the firm who employed the deceased lad. If the factory inspector chose to spend a fortnight in a similar factory, he would probably know more and guess less.

F. E. Everard.

May 18th, 1897.

Pole Finder.

A handy way of finding out the + and − of a circuit to connect a meter or any other apparatus is not known to many electricians. I have before now seen how the men who have to give current to a new installation and join up the meter, had to send to the office for pole paper before they could go on. The following is a far easier way and just as sure :—

Take a lampholder with wires and a 16 or 32 C.P. lamp. Join one wire on one of the mains, and a free wire on the other. See that the two free ends are of thin wire—say 24; let the two ends meet and just separate a little till a small arc is formed—you see one of the wires gets hot and a small ball forms at the end, this is in all cases the +, the other keeps cold. I am sure this will be handy for many electricians, as it is of very great use to me, and I have found it very handy as a lamp and wire are always in stock at a place where a test is necessary, if you should have to take down a pendant for it.

J. D.

Mr. Raworth's Paper.

Mr. J. S. Raworth's paper on the "Generation of Electrical Energy for Tramways" may be considered to be a valuable and timely contribution to this important branch of electrical engineering, and raises several points for discussion.

In the first place with regard to motive power. There is no doubt that steam engines are made in this country every day, amply strong, and in every way capable of working satisfactorily under the sudden fluctuations of load common to all tramway installations.

I have a drawing of a Raworth engine before me, in which the main bearings have a length equal to 2·4 diameters; certainly an ample proportion.

The arrangement of valves in Mr. Raworth's engine permits of very short steam ports, a most important point in securing economy of steam.

The shaft governor is especially suitable for high speed engines adapted for this class of work, as on account of the high speed of shaft the governor can be kept within reasonable dimensions. At the same time the sweeping condemnation sometimes expressed with regard to ball governors, belt or shaft driven, should be accepted with due reservation.

For slow running engines, such as mill engines, or those used for driving the generators for the Liverpool Overhead Railway, the ball governor is very sensitive, and generally efficient. Where "knock off" gears are attached, as they are by Mr. Ben. Goodfellow, of Hyde, and other well known makers, an accident from the engine running away or from sudden large fluctuations of load, is practically impossible. The "knock off gear" cuts off steam entirely when the speed exceeds the safe limit, and acts both at the highest and lowest position of the governor balls.

The price of coal quoted by Mr. Raworth in his paper, namely, 10s. per ton, is somewhat high for the Manchester district; but it is questionable whether coal could be ob-

tained in London or the southern counties at anything like so low a price. It is customary to use a very inferior class of coal in the Manchester cotton mills, in some cases little better than coal dust, mechanical stokers being almost invariably applied to the boilers.

With the growth of electric traction a demand for combined power and lighting stations will undoubtedly ensue, and the problem of effecting this in the most satisfactory manner will present itself for solution.

A dynamo built for lighting purposes is not suitable for a tramway generator. The latter type of machine must be mechanically stronger, and the electrical conductors must be more perfectly insulated. The manner in which this improved insulation and increased mechanical strength attained is well understood. The method of inserting the armature conductors in grooves slotted in the iron core being, perhaps, the best known.

Recent American practice, as treated of in Mr. Baylor's paper, read at the Institution of Electrical Engineers, and by other authorities, demands the use of multipolar generators with toothed core armatures, while in England bipolar machines with smooth cored armatures are the rule. It is obvious, however, that the latter type of machine is quite unsuitable for the requirements of a tramway generator. It seems probable, therefore, that combined power and lighting plants will comprise at least two classes of generator; one working at about 500 volts for power works, the other a lighter type of machine working at 250 volts for lighting purposes. It may be possible to decrease the first cost of the plant by coupling a lighting dynamo at one end of the engine shaft, and a tramway generator at the other, either machine being arranged to switch out circuit at will. This arrangement would have the incidental and important advantage of increasing the fly-wheel effect, the space occupied by the plant being at the same time reduced.

The day load and tramway circuit might thus be provided for by one engine.

As the demand for lighting current increased, it is probable that in many localities the demand for traction current would decrease, so that a tolerably uniform load could be ensured. In places where this equality of load could not be counted upon, the plant would have to be duplicated in order to provide the necessary power at full load.

Various useful combinations would be possible with the duplicated plant; for instance, by coupling two engines to a pair of tramway generators, and a pair of dynamos wound for 250 volts each; the three-wire system might be adopted for the lighting circuits.

In some stations it will probably be found necessary to provide a third type of dynamo wound for a lower voltage suitable for charging accumulators for motor cars, electric launches, portable lamps, &c.

By such combinations as suggested above, the cost of production of electrical energy may be minimised, and the demand for current for lighting and other purposes consequently stimulated.

George Adams.

May 15th, 1897.

An Explanation.

In an account of the meeting of an engineering society, I notice that you describe me as a member of the staff of the Brush Electrical Engineering Company. May I ask you to let me state that I am not a member of that company's staff, and that I was present amongst my former associates only as a friend—a relation that, I hope, may always continue?

I may remove misconception if I explain that, except in so far as the Brush Company continues to manufacture under certain former patents of mine, and that I have the honour of being retained by the Company to act as consulting electrician when called upon, I am in no other way to be considered as connected with that or any other Company.

W. M. Mordey.

London, *May 17th*, 1897.

Publishing Net Prices.

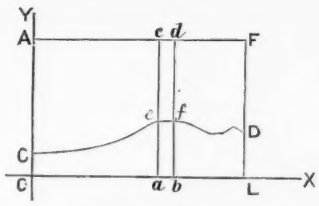
I notice with surprise that some of your advertisers have begun to publish their *net trade prices*. I am sure that the results will be extremely disadvantageous to all contractors, as the ELECTRICAL REVIEW is read by many persons other than electrical engineers.

Contractors have already suffered enough through unscrupulous manufacturers and agents selling direct to the public, without having the prices at which they purchase published. I feel sure that all contractors will agree with me in this. Contracting work is already sufficiently cut in price without any further competitions.

P. Speedy.

Hydro-Electric Methods in Medicine.

In the ELECTRICAL REVIEW of last week you publish a letter from Dr. Hedley in which he asks for further information about a method of measuring the resistance of the human body in the electric bath. He admits that the principle of the method recommended is right; he considers, indeed, that it is a truism, but he does not see how it can be carried out without a surgical operation. It is superfluous, perhaps, to say that the "short sections" meant were mathematical, not surgical, sections. Another objection raised by Dr. Hedley is that "no such portion of the body has uniform conductivity." Now if the section is sufficiently short, in the direction of the lines of current flow, it is evident that the conductivity of the body will be sensibly constant or uniform throughout the section. What was recommended was simply the well known mathematical process of integration, which is the only accurate method of dealing with varying quantities such as the factors of the electric bath. Dr. Hedley still holds the opinion that the total resistance is all that concerns the question; now unless the electric current has been good enough to perform the process of integration for Dr. Hedley, and to indicate the result on his instruments, he will not be able to get the "total resistance" by the method which he adopts. The following investigation, will, I think, show that only under very exceptional conditions would the total resistance be correctly measured by Dr. Hedley's method. In the figure let O X, O Y be axes of co-ordinates, and let O L represent the length of the bath, and O A the sectional area of the water and immersed body. Let the ordinates of the curve C *e f* D represent the sectional area of the body at the corresponding points along the bath.



Let a short section of the body and bath water be cut off by two parallel planes (represented by the lines *a c e* and *b f d*) normal to the direction of current flow.

Let I = the total current flowing through the bath.
i_1 = the current flowing in the water between the two given planes.
i_2 = the current flowing in the body between the two given planes.
k_1 = the specific conductivity of the water.
k_2 = the specific conductivity of the body.
d E = the E.M.F. between the two planes.
$d r_2$ = the resistance of the section of the body between the two planes.
y = the section of the body between the two planes, *i.e.*, the ordinate of the curve.
A = the total section of the water and body which is constant.
R = the total resistance of the body in the bath.

Then

$$\frac{i_2}{i_1} = \frac{k_2\, y}{k_1\,(\text{A} - y)}$$

$$\frac{i_2}{i_1 + i_2} = \frac{k_2\, y}{k_2\, y + k_1\,(\text{A} - y)}$$

$$i_2 = \text{I}\,\frac{k_2\, y}{k_2\, y + k_1\,(\text{A} - y)} \qquad (1)$$

The density of the current in the given section of the body is

$$\frac{i_2}{y} = \text{I}\,\frac{k_2}{k_2 y + k_1 (\text{A} - y)} \qquad (2)$$

This, I think, ought to be the most important quantity in electro-medical treatment. We can see from this equation that the density of the current in a particular part of the body when a constant current is flowing through the bath depends on the sectional area and the specific conductivity of the part in question.

From equation (1) we can determine the total resistance of the body.

$$d\,r = \frac{d\,\text{E}}{i_2} = \frac{d\,\text{E}}{\text{I}} \times \frac{k_2 y + k_1 (\text{A} - y)}{k_2 y}$$

$$\text{R}_2 = \frac{1}{\text{I}} \int_0^{\text{E}} \left\{ 1 + \frac{k_1 (\text{A} - y)}{k_2 y} \right\} d\,\text{E}$$

$$= \frac{\text{E}}{\text{I}} + \frac{k_1}{\text{I}} \int_0^{\text{E}} \frac{\text{A} - y}{k_2 y}\, d\,\text{E}.$$

Now this last expression cannot, as a rule, be integrated except we know y in terms of E, which we do not. There are some exceptions; for instance, when both y and k_2 are constant the expression can be integrated. This, of course, is the case taken as an illustration in Dr. Hedley's book, and the resistance can be found in the way he describes, of an immersed body of uniform section and uniform conductivity. But our investigation has shown that Dr. Hedley is not justified in extending the same method to bodies of varying section and conductivity like the human body.

The total resistance of the body cannot therefore be calculated from current and E.M.F. measurements as described by Dr. Hedley. Nor does this total resistance appear to be of much use for electro-medical purposes when it is obtained. The resistance can only be correctly ascertained, as far as I can see, by the somewhat laborious process of measuring separately the resistances of short sections by means of the equation

$$d\,r_2 = \frac{d\,\text{E}}{i_2} = \frac{d\,\text{E}}{\text{I} - \dfrac{d\,\text{E}}{d\,x} (\text{A} - y)\, k_1}$$

which contains on the right hand side quantities which can all be measured by adding these resistances together. d E, or the E.M.F. between two points on the body a short distance apart, can be measured by touching the points with insulated wires connected to a potential meter.

The density of the current at any particular part of the body could be ascertained by a single set of measurements, or by a single measurement of d E when all the other factors had been previously ascertained.

Whatever may be Dr. Hedley's objections to Kohlrausch's method of measuring the resistance of electrolytes, they are not shared by Dr. R. Lüpke, the author of one of the latest and best works on Electro-chemistry.*

The Reviewer.

TELEPHONE FACILITIES.

The National Telephone Company, Limited, has sent us an advance copy of a circular relating to arrangements which have been made between the Postmaster-General and the company for the extension of Post Office services to subscribers of the company connected with exchanges within the London postal area. The circular reads as follows:—

"Arrangements have now been concluded with the Postmaster-General by which subscribers connected to the exchanges of the company shown on the annexed list will, on and after June 1st next, be enabled to telephone a message, for:—

"(*a*). Transmission over the postal telegraphs and delivery as a telegram.

"(*b*). Delivery as an express letter.

"(*c*). Conveyance and delivery as an ordinary letter, or

"(*d*). Calling for the services of a Post Office express messenger.

"Subscribers desiring to make use of these services will please to observe the following rules.

"(*a*). When a subscriber desires to telephone a message for transmission as a telegram, he must in all cases notify his exchange that he requires the 'Telegraph Service,' when he will be put into communication with St. Martins-le-Grand. This service is available day and night, including Sundays and holidays.

"(*b*). If it is desired that a message should be taken down by the Post Office and delivered as an express letter, the Post Office which is connected with the nearest exchange to the destination to which the letter is addressed, should be asked for. (See list of offices annexed).

"(*c*). Should it be desired that a letter be written out by the Post Office and forwarded by ordinary post, the Post Office connected to the exchange to which the subscriber is himself connected should be called for.

"(*d*). Where the services of a Post Office express messenger are desired (1) to convey a message or parcel from the subscriber's premises, the Post Office to which his own exchange is connected must be asked for. (2) To fetch a parcel or letter, from some distant place and bring it to the subscriber's premises, the Post Office mentioned on the annexed list, nearest to the place from which the message or parcel has to be fetched, must be asked for.

"Any other of the express letter services referred to in the Post Office Guide can be obtained by calling the appropriate Post Office.

"Subscribers making use of these services are required to make a deposit with the company sufficient to cover the estimated amount of fees incurred for the use of this service during one month, unless they have already made a deposit in respect of the trunk wire or telegram services.

"Further information can be obtained at any of the company's offices.

"Wm. E. L. Gaine,
"*General Manager.*

"Oxford Court, Cannon Street,
"London, E.C., *May*, 1897."

THE SWANSEA TRAMWAYS.

A Select Committee of the House of Lords, under the presidency of Lord Erne, sat on Wednesday last to consider the Swansea Corporation Tramways Bill. There were about 30 petitions against the Bill, but the majority of them were not appeared upon by counsel. Mr. Pember, Q.C., Mr. Freeman, and Mr. Lloyd appeared for the promoters of the Bill, and the following petitioners were also represented:—The Swansea Gas Light Company by Mr. Balfour Browne, Q.C., and Mr. Meager; Vivian & Sons, and others, by Mr. Rickards; owners and ratepayers of St. Ayre, &c., by Mr. Balfour Browne, Q.C., and Mr. Statham; Howell, Jones & Co., by Mr. Balfour Browne, Q.C., and Mr. Statham; Frederick Naylor and others, by Mr. E. Boyle and Mr. Willis; the Rhondda and Swansea Bay Railway Company by Mr. Worsley Taylor, Q.C., and Mr. Frere; owners and occupiers of premises fronting High Street, by Mr. Bevan; Mr. William Rook, and other ratepayers of Swansea, by Mr. Boyle.

Mr. Freeman, Q.C., in opening the case for the Bill, said he appeared with Mr. Pember and Mr. Lloyd. Shortly, the Bill was one to enable the Corporation of Swansea to purchase the tramway undertaking and to construct other tramways, and for other purposes. The Bill was a very simple one, asking for sanction of an agreement which had been entered into between the Corporation and the tramway company to take their tramways on terms which it was believed were beneficial to both parties. In 1874 the tramways company obtained powers to construct certain tramways; in 1879 they obtained power to construct other lines, and in 1882 still further extensions were authorised. All these tramways would have been subject to the General Tramways Act of 1870, which provided that in cases where the local authorities were not the owners, they might at the end of 21 years purchase the tramways upon certain terms. In the Act of 1882 a section was introduced which modified the general Act, which provided that no part of the tramways forming the system of the company should be purchased by the Swansea Corporation until 21 years from the completion of the tramways authorised by that Act, and therefore it would not be until 1903 that the Corporation would be entitled to buy all the tramways in the borough. There was a provision in the clause that when the Corporation should purchase the tramways, they should grant a lease to the company of 21 years from the date of such purchase. In consequence of that, negotiations took place between the tramway company and the Corporation, who wished to acquire the trams before 1903, and an agreement was come to between the Corporation and the company which was the agreement which their Lordships were asked to sanction. Shortly, the terms of the agreement were that the Corporation were to pay for the existing tramways £32,000, and they were also to construct the additional tramways which were in the Bill before their Lordships. The company were to take a lease for 21 years of the tramways, and to pay a rent made up of three component parts—first of all of interest upon the money so paid by the Corporation; secondly, such an amount as would form in 30 years a sinking fund to repay the purchase money paid for the tramways; and thirdly, such an amount as in 21 years would form a sinking fund to repay the money expended on the new tramways. The long and short of the agreement was that at the end of 21 years, when the lease expired, the Corporation would have become possessed of the old tramways which had been put into proper condition and repair by the company, and the new tramways, without ever having paid one farthing. A further part of the agreement was that the Corporation should supply electricity to the company at the rate of 2d. per unit for every 600,000 units taken in the year. If the company took 750,000 units then the price was to be 1¾d., but if they took anything beyond 750,000 units in the year, the price was to be reduced to 1½d. There was a further clause that the company were never to take less than 400,000 units in any year from the Corporation. The object of that was this—the Corporation were desirous of supplying electricity to the town of Swansea for lighting purposes, and they had powers at the present time enabling them to do so, and he need not tell their Lordships that the whole tendency

* "Elements of Electro-Chemistry," by Dr. R. Lüpke, 1897.

of modern times had been to obtain electric light for illuminating purposes. The only question which had stood in the way was that of expense, but if the tramways company were in a position to take this large amount of electrical energy in the day time, and which would relieve the Corporation of what was termed the day load, it would greatly reduce the price at which they would be able to supply electric light in the borough, and would enable the Corporation to supply electricity on cheaper terms than it could be supplied by any other town in the kingdom. That would be a very great advantage to the borough, and particularly to the tradesmen and the manufacturers there. The only other thing in the Bill the Corporation sought power for, was to buy certain land on which they proposed to erect their generating station, and they also proposed to buy certain land for the widening of the street in certain parts where the tramway was going to be carried. Upon the land which they proposed to buy for the purpose of putting their electrical works, they also proposed to put up a refuse destructor, which would enable them to do away with the exceedingly cumbersome method by which the refuse was dealt with at the present time. The tramways up to the present time had undoubtedly not been a very remunerative concern. They were at present entirely worked by horse-power, but the companies had not been able to give anything like a regular service so as to tempt people to rely upon them and use them; and further, they did not go so far as they were required in various directions. The contention of the Corporation was that on the basis which they were going to buy the tramways, they would be enabled to work them satisfactorily and successfully. They had been advised on that point by probably the most eminent gentlemen whom they could have consulted—Lord Kelvin, Mr. Preece, Prof. Silvanus Thompson, Mr. A. Wright, who had control of the electrical works at Brighton, Mr. Manville, engineer to the Swansea Corporation, and Mr. George Hopkins, who had constructed more tramways in the metropolis and the country than anybody living. Those gentlemen would be called to say that they saw no sort of reason why the company which took the lease should not be perfectly able to pay the Corporation its rent, and to divide a fair profit among their shareholders. It was intended to substitute electricity for the present horse traction, which would have not merely the advantage of a speedy and regular service, but would also have the effect of bringing the trams more under control, by enabling them to turn corners easier, and it would also be safer in going down steep gradients. Unfortunately the Corporation came into conflict with a body known as the Swansea Gas Light Company, which had come to the conclusion that if the Corporation were enabled, by supplying electricity to these tramways, to also supply electricity as an illuminant at a far cheaper rate to private people than they otherwise would be, a formidable competitor would be raised up against them, and the gas company, who up to the present time had been paying very fine dividends, would find that dividend reduced. Practically, the whole of the opposition came from the Gas Company, who were fighting tooth and nail against any proposal of the Corporation which would enable them to supply cheap electricity to the borough, and so compete with them. The company had supplied gas for a considerable time, and there had been many complaints both as regarded the quality and the pressure. The charge which they made was 3s. per 1,000 feet to private consumers, and 2s. 10d. to the Corporation; and to show that that was a matter of considerable importance to the Corporation, he might say that their annual gas bill for public lamps alone came to £5,220, and as private consumers, they took some £200 worth of gas each year. The borough was polled in reference to the Bill, and there was a majority of 886 in its favour. He was not sure that the gas company had any *locus standi* before their Lordships, but the Corporation had determined not to take any technical objection, but to fight the objection on its merits.

Mr. Balfour Browne took an initial objection to the Corporation going on with the Bill, on the ground that it did not represent the opinion and wishes of the ratepayers of the borough.

Mr. Freeman said that if there was anything in that point his friend should have moved in the law courts to restrict the Corporation from going on with the Bill.

Lord Erne said the point Mr. Balfour Browne had raised was a very important one, but it must be considered in connection with the whole case, when it would no doubt form an element for the consideration of the Committee.

The Mayor of Swansea (Mr. Watkins) was then examined by Mr. Freeman, and was taken through the proceedings which have taken place in the Town Council leading to the promotion of the Bill. Personally he had taken a great interest in the tramways question, and in his opinion increased facilities in that direction were badly needed in Swansea. He believed that it would be a considerable advantage to the borough if the Bill was passed, and he believed that if the undertaking was carried out on the lines as proposed it would be a success. He was well acquainted with the streets of Swansea, but did not consider that they were so congested that there would be any danger in the event of electrically equipped tramways passing up and down them. They had had the question of a generating station under their consideration from time to time, and the site they wished to erect it on had many advantages.

The Witness was cross-examined at great length by the various opposing counsel as to the legality of the poll that was taken on the question of the Bill, and he maintained that everything had been done in perfect order. Replying to Mr. Meager, he said that the Corporation obtained their provisional order for electric lighting in 1889, but they had not yet supplied the light, probably because they did not think they could make it pay. He felt certain, however, that they would make it pay under this agreement, because it would relieve them of the day load.

Mr. Worsley Taylor informed the Committee that terms had been arranged between the promoters of the Bill and the Rhondda and Swansea Bay Railway.

Sir John James Jenkins, M.P., was next called, and replying to Mr. Lloyd, said he had given the scheme of the Corporation great consideration, and he believed it could be carried out with pecuniary advantage to the borough. He was well acquainted with the streets of Swansea, and although he could not say they were unsuitable for electric tramways, they would be more suitable if they were wider. He did not think there would be any danger in running electric cars. Swansea Harbour was lit by electricity at the present time by private contract, but possibly if the Corporation could supply them with the light at a less cost than they now paid, they might take their light from the Corporation.

The Committee then adjourned.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending May 18th, 1896.	£	s.	Week Ending May 18th, 1897.	£	s.
Albany. Teleg. mat. ...	2,634	0	Alexandria	70	0
Amsterdam	120	0	„ Teleph. mat.	23	0
Antwerp...	107	0	Amsterdam	30	0
Bangkok	63	0	Bilbao	25	0
Bombay. Teleg. mat. ...	63	0	„ Teleg. mat. ...	21	0
Boulogne	10	0	Buenos Ayres	30	0
Buenos Ayres. Teleg. material	120	0	„ Teleg. wire	407	0
Calcutta	238	0	Calcutta	133	0
Cape Town	72	0	Cape Town	583	0
Colombo...	218	0	Cologne	480	0
Copenhagen. Teleg. mat.	58	0	Colombo	18	0
Delagoa Bay	81	0	Copenhagen. Teleg. mat.	12	0
Durban	63	0	Delagoa Bay	86	0
East London	210	0	Durban	246	0
Flushing	43	0	East London	121	0
Fremantle	99	0	Gothenburg	386	0
„ Teleg. mat.	850	0	Hamburg	54	0
Gothenburg	9	0	Malta	96	0
„ Teleg. wire	52	0	Marseilles	73	0
Jersey	130	0	Melbourne. Teleg. mat.	85	0
King George's Sound ...	799	0	Montreal	25	0
Launceston	74	0	Rio Janeiro. Teleg. mat.	133	0
Melbourne	171	0	Rosario	212	0
Monte Video	145	0	Sandakan. Teleg. mat.	19	0
Rosario	644	0	Sarawak. Teleg. mat.	15	0
St. Petersburg	617	0	St. Petersburg. Teleg. cable	214	0
„ Teleg. mat.	1,232	0	Singapore. Teleg. mat.	69	0
Seville	7	0	Stockholm	58	0
Singapore	10	0	Sydney	719	0
Sydney	1,145	0	Vera Cruz	21	0
„ Teleg. cable ...	1,050	0			
Spezia	110	0			
Trieste	6	0			
Total	£11,250	0	Total	£4,464	0

Foreign Goods Transhipped.

	£	s.
Syracuse	27	0

Agencies.—Mr. S. Jevons, of the Electrical Supply Stores, The Minories, Birmingham, has been appointed sole agent for the sale of Messrs. Connolly Bros. manufactures in the Midland Counties of Warwick, Worcester, and Staffordshire (not including the Pottery District), and will hold a good stock of their wire, cables, and Blackley Tape, &c., to meet all urgent orders.

Messrs. F. A. Putz & Co., of Mansion House Chambers, 11, Queen Victoria Street, have been appointed sole agents for the United Kingdom of the Vereinigte Electricitaets Actien-Gesellschaft vormals B. Egger & Co., in Vienna. They will keep a small stock in London for that firm. An English catalogue will be issued shortly.

Auction Sale.—Messrs. Percy Huddleston & Co. will sell by auction, at 16, Long Millgate, Manchester, on Thursday, June 3rd, the stock of an electrical engineer, comprising dynamos, motors, arc lamps, switches, ceiling roses and cut-outs, lampholders, measuring instruments, and various other electrical apparatus; also gas engines, launches, engines and boilers, &c. See our "Official Notices" for particulars.

Blackley Tape.—Messrs. Connolly Bros., Limited, believe that cheap and inferior imitations of "Blackley Tape" are now being offered to the trade, and as this article is growing in favour, they wish it to be known that it is manufactured by them only at their Blackley Works, Manchester. To insure getting the genuine article, users should insist on being supplied with same in the original packets, each roll being stamped on one side with the name of the tape, and on the reverse with the maker's name. Each is separately packed in a box, with a special wrapper bearing the T-joint illustration.

Catalogue.—The Electrical Company, Limited, of Charing Cross Road, have just issued a new electrical fittings catalogue, which they will furnish to smaller trade houses without their name for obvious reasons. The book consists of about 50 pages of excellent illustrations, and as a thick paper has been used, these show up to advantage, the artistic features of many of the fittings

being very effectively displayed. Electroliers, brackets, ceiling fittings, standards, bronze figures, candle brackets, fancy shades, and similar pieces of work, are shown in excellent variety, and the catalogue does credit to the Electrical Company from the beautiful fittings standpoint, as well as to the engraver and printer for the attractive illustrations and their arrangement.

Change of Address.—Mr. Killingworth Hedges, M.I.C.E., has removed his office from 28 to 92, Victoria Street, S.W., and his laboratory to Emery Hill Street, Francis Street, Westminster.

Dissolution of Partnership.—The partnership heretofore subsisting between Messrs. Stephen Sellon and V. B. D. Cooper, carrying on business as engineers at Broadway House, Westminster, under the style or firm of Sellon & Cooper, has been dissolved by mutual consent as and from May 3rd, 1897, except as regards the appointments of the said Stephen Sellon as engineer to the Dover Electric Tramways, and as engineer to the North Staffordshire Tramways Company, Limited, under the existing arrangements for the electrical equipment and reconstruction thereof, until the termination of such works, in respect of which said appointments the partnership will continue until the termination thereof.

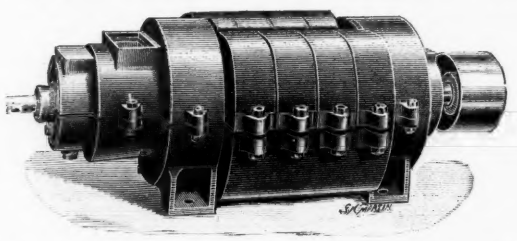
Electric Launches.—An electric launch named *Electra* is now running on the Dee. She was built by the Thames Valley Launch Company, and is 35 feet long, carrying 40 E.P.S. accumulators. The Chester Boating Company also contemplate placing several additional electric launches on the river.

Exchange Telegraph Company v. Central News and Others.—In the Chancery Division on Wednesday, Mr. Justice Stirling gave judgment in the action brought by the Exchange Telegraph Company against the Central News and the Column Printing Telegraph Company for an injunction to restrain them from copying their racing results. Both defendant companies denied the alleged copying. The application against the Central News was dismissed, but granted with costs against the Column Printing Syndicate.

Fire.—A slight fire occurred at the Charlton Works of Messrs. Siemens Bros. & Co. early on Tuesday morning. The damage was not extensive.

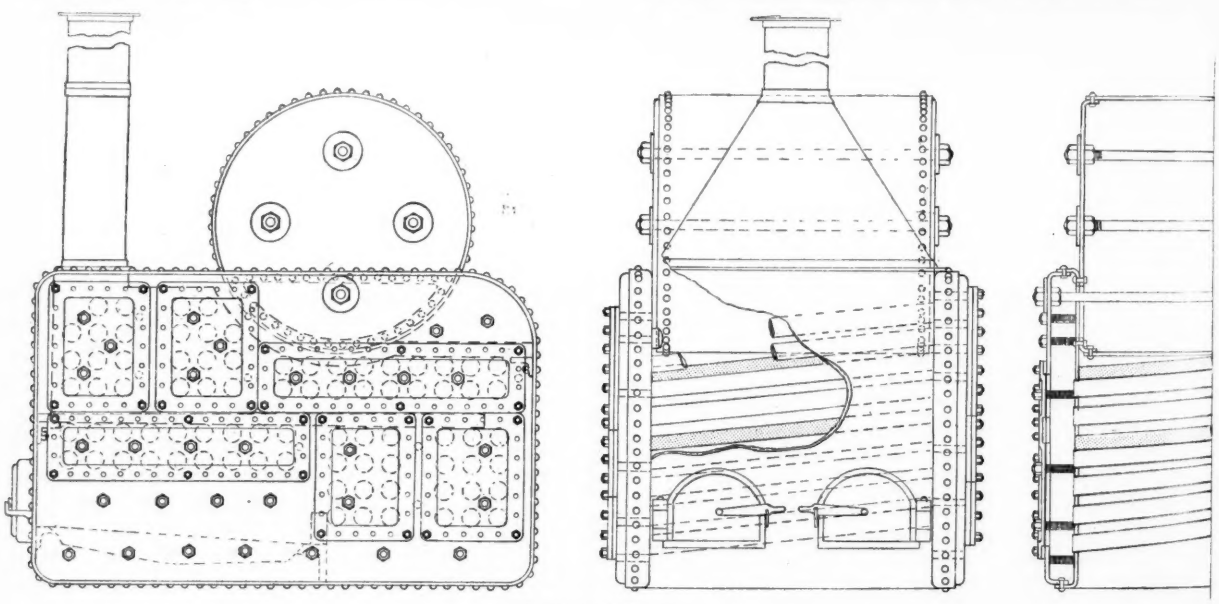
Gas.—On 12th inst. a gas explosion at Park Street, Motherwell, caused damage.

The "Enclosed" Motor.—The Edison and Swan United Company are making the Ediswan patent "Enclosed" continuous current motor at their Broadheath works. We learn that it has been designed to meet the demand for a motor which could safely be placed in situations where it would be exposed to damp or dirt, as it



is entirely enclosed. It is proof against atmospheric influences, and is protected against mechanical injury. Although enclosed, all parts are easily accessible, and the armature can be removed in a few minutes. The motor is reversible, and runs sparklessly at all loads without any movement of the brushes. The bearings are provided with automatic continuous oiling arrangements. The motor is shown in the illustration.

The Sandford Boilers.—A new vertical boiler is being manufactured by Messrs. E A. & H. Sandford, of the Thames Ironworks, Gravesend, who have secured the patent rights in the United Kingdom and in all countries. The boiler is said to be specially useful for the following purposes, viz., steam cranes, steam launches, and small cargo steamers and ships' donkey boilers, and stationary purposes. For the latter, where only inferior fuel can be obtained, they are believed to be particularly suited. Among the advantages claimed for it, may be cited its simplicity and lightness of construction, its great efficiency, and the heating surface is stated to be considerably more than an ordinary boiler (size for size). The boiler lends itself to the quicker raising of steam without injury to the boiler. Inferior fuel can be burned, the boiler having a larger fire grate (rectangular). The furnace bars are single, and are fitted with automatic clinker-



Sandford's Boiler.

Jubilee Illuminations.—Messrs. Strode & Co. are giving a good deal of attention to illumination designs for both gas and electric light. They have various designs of the Imperial Crown, mottoes, moons, balloons, &c., in all colours. We have received from the firm a price list of their devices, also a book of blue print designs specially prepared for the forthcoming celebration. Those firms who intend going in for illuminations will find plenty to select from.

There are various proposals on foot for the illumination by means of the electric light of St. Paul's Cathedral dome and the Houses of Parliament.

Lamp Pillars.—The contract for the electric light pillars for Paisley has been secured by Messrs. Walter Macfarlane & Co., who have also secured a similar contract for Johannesburg.

Phonograph Patent Infringement.—On Saturday last Mr. Bremmer, in the action of the Edison-Bell Phonograph Corporation, Limited, *v.* Taylor, asked Mr. Justice Kekewich, sitting in the Chancery Division of the High Court of Justice, to give the plaintiffs judgment in an action they had brought for the infringement of their phonograph patent, the defendant not having put in any defence; and his lordship saying he had looked through the papers and the formalities appeared to have been complied with, granted the application, with costs.

loosening apparatus. High pressures can be used. No skilled labour is required to work it. It has the advantages of the modern rapid water-tube steam generator without its disadvantages, and with even greater safety than ordinary boilers, due to the steam and water receivers being so much above the water tubes, and the receiver fitted with a fusible plug, it is almost impossible for the tubes to be without water. This portion of the design also secures immunity from priming. Excellent and easy provision is made for cleaning the boiler by means of doors, and these doors provide for the easy removal and replacing of new tubes, and the expanding of the tube ends with an ordinary tube expander. These facilities permit the use of salt and all ordinary water. Messrs. E. A. & H. Sandford also make a larger type boiler of horizontal form, of large power, for steamships and stationary purposes. This boiler partakes of the principles of their vertical boiler, but in its construction the hot gases are made to return after passing along the furnaces over the bridges and among the bottom tubes, and then return among the upper tubes to the chimney, and with this construction the heating surface and power of the boiler may be increased to a higher efficiency than hitherto obtainable, according to the size and power of boiler required. It has the same facilities for cleaning boiler and removal and replacing of tubes, together with automatic clinker apparatus similar to the vertical type of boiler.

Thetford Electric Light and Power Company.—Whether this company should be wound up voluntarily or compulsorily under the supervision of the Court, formed the subject of an *ex parte* application by Mr. Stokes to the Master of the Rolls and Lords Justices Smith and Chitty on Monday last. His client, the learned counsel said, was the holder of nearly one-half of the share capital, viz., 175 shares out of 368. The judge of the Ipswich County Court had dismissed a petition to wind up, and subsequently a meeting for voluntarily winding up was held, at which, according to the case for the plaintiff, the chairman improperly counted the votes, and not in accordance with the company's Articles of Association. As winding up was inevitable, though his client thought the creditors would be paid in full, he preferred that it should be under the supervision of the Court, which could inquire into some matters the plaintiff alleged against the directors; and he submitted that in these circumstances he was entitled to appeal against a decision of a Divisional Court refusing to make a compulsory order. After hearing the learned counsel, the Master of the Rolls said the Court declined altogether to comply with the request made to them; they thought it very improbable that both the County Court Judge and the Divisional Court had arrived at a conclusion with which they ought to interfere.

ELECTRIC LIGHTING NOTES.

Ayr.—The Police Commissioners have adopted the recommendations of Mr. Fuller, the electrical engineer, to enter into an agreement with the Free Wiring Syndicate. The number of lamps connected is 6,925, with a further 569 waiting.

The Police Commissioners have decided that the charges for the coming year shall be 6d. per unit for the first hour and 4d. per unit thereafter, and that the Brighton system and the demand indicators be adopted.

Barking.—The District Council has asked an electrical engineer to draw up specifications, &c., for an electric lighting scheme so as to guide them in their decision on the subject. There is a proposal to run a system of tramways from Barking to Beckton as a municipal venture, but it has not yet taken practical shape.

Bath.—The Local Government Board has, in consequence of a protest, decided to hold a further inquiry into the application of the Council for a loan of £6,800 for electric lighting extensions.

Brechin.—The manager of the company which raised the electric lighting question is to be in Brechin in June, when the Commission sitting in committee will meet him.

Birmingham.—The General Purposes Committee has referred the question of the purchase of the electric light undertaking to a sub-committee.

Bristol.—The Electrical Committee has decided to lay a main to Downfield Road if a sufficient number of applications for lighting is obtained. The Mayor has submitted plans showing the proposed illuminations at the Council House on the occasion of the diamond jubilee celebrations. The work has been entrusted to a local firm.

Canterbury.—The Local Government Board inquiry held last week regarding the electric lighting loan was unnecessarily protracted. There was a lengthy opposition and examination of witnesses, Mr. Dickens, Q.C., appearing for the opposition party. The opposition, though lengthy, was exceedingly weak, the chief point being that it was an injustice to allow electric lighting to be introduced where the gas lighting had given satisfaction for so many years.

Carnew.—A movement is on foot to light the town of Carnew (Ireland) with electricity. Lord Milton has promised £450 towards this object, and the required amount will be subscribed by the traders of the town.

Resolven.—Messrs. Sydney F. Walker & Co. are stated to have secured the contract for lighting the village of Resolven, in the Vale of Neath, in connection with the adjacent works of Messrs. Cory Bros., Ltd.

Glasgow.—A Glasgow paper says that the electric lighting of the city is about to undergo extensive alterations and developments. At the present time the lamps of the city, to the number of 108, are lit by the high tension system from the station in John Street, where there are two 200 horse-power engines of modern type, and in first-class condition. Arrangements are proceeding whereby in a short time the lighting of the lamps will be carried out from Waterloo Street on the low tension system, which will leave the new Electricity Committee of the Corporation with the powerful engines at John Street on hand. In the construction of the new electric overhead tramway line from Mitchell Street to Springburn, Mr. Young, the manager, and Mr. Walter Paton, the convener of the Tramway Committee, propose to lay down a generating station of their own at Springburn, to supply the electric power to be applied in working the line. What the Electricity Committee maintain is that instead of going to the expense of laying down a new station at Springburn, the electric power can easily be supplied from John Street. The dynamos, no doubt, would require some alteration, but the Electricity Committee maintain that this could be done, and the necessary connections made inside two months, when everything, in fact, could be in perfect order for the power required for the tramway traction. So convinced, indeed, are the Committee of their power to accomplish this, and of the immense saving it would be to the city, that they have already appointed a committee of four to meet the Tramway Committee and press their claims. But, as indicated, there is another side to the question—Mr. Young and the Tramway Convener being decidedly against the proposal made by the Electricity Committee, so that the future proceedings will be watched with great interest. The present current from Waterloo Street Station is about 17,000 amperes, but with the addition of two new battery stations in course of erection, this will be raised to about 22,000 amperes.

Guilford.—The Council has declined the offer of the Electric Light Company to lay a main for the supply of electricity to the public baths, provided a minimum charge of £25 per annum was paid in respect of the light, and that the Council also adopt the light at the offices in Tuns Gate.

Hornsey.—The District Council having considered the letter received from Edmundsons, Limited, in regard to the introduction of electric lighting, have decided not to entertain the proposal for the present.

Lincoln.—The Council is still discussing the electric light question. The works contemplated were first estimated to cost £14,600. The engineer, in a later estimate, carried the total to £17,000, and now it has further developed to £20,000. At the last sitting of the Council a prolonged debate was attended with no practical result, and it was decided to discuss the matter in committee.

Liverpool.—The Corporation surveyor has prepared plans for the extension of the Oldham Place station, and tenders for the execution of the work are to be obtained. Four arc lamps are to be placed on the plateau of St. George's Hall.

London.—The Court of Common Council had before it last week an application from Messrs. Sax for permission to transfer the lease of the buildings in course of erection in Charterhouse Street and the concession for lighting the central markets to Messrs. Jacob Van der Burgh and Sir John Morris, K.C.S.I. The matter was adjourned.

Manchester.—The electric lamps erected in three of the principal places of the city were brought into use for the first time last night. The ceremony of switching on the current was preceded by a little dinner party at the Town Hall. In all, the new lamps number 20, of which 12 are in Albert Square, two in St. Ann's Square, and six in Piccadilly, and it is understood that they will displace about 75 large gas lamps.

Mile End.—The Vestry last week adjourned the consideration of the report of the Electric Lighting Committee regarding the County of London (East) provisional order.

Newcastle.—A Corporation deputation has visited Southport for the purpose of inspecting the electric lighting arrangements there.

Newington.—The Board of Trade have addressed a letter to the Newington Vestry in which they state that after carefully considering the representations which have been made to them in respect of the Newington Electric Lighting Provisional Order, they have decided to proceed with the application. This is, of course, a very important decision when the history of the application is remembered, the electric lighting proposals having been most bitterly, and in some cases unfairly opposed by a certain section of the local men in the district. The Bill has been introduced into the House of Lords for confirmation under the title of The Electric Lighting Provisional Orders (No. 11) Bill.

Newmarket.—The District Council have resolved to accept the terms of Messrs. Edmundsons, Limited, for the transference of their electric lighting order, the average of 5 per cent. to be reckoned as the annual income of the company in case of negotiations being entered into for the purchase of the works.

Onchan.—A public meeting held last week to consider means for celebrating the Queen's Diamond Jubilee, decided to light the village by electricity. Knowing that the Isle of Man Tramways and Electric Power Company were contemplating lighting Douglas with electric light, the chairman thought it was proper to ascertain the cost. Mr. Bruce, the chairman of the Tramway Company, replied that the company would undertake to procure subscriptions to the extent of £75, leaving £225 to be found by the village. They proposed to light the village with five lamps. The proposal was unanimously adopted by the meeting. The chairman replied that they hoped to have the lamps lit for June 22nd.

Paris.—A Reuter's Paris telegram says that several places of entertainment in the Champs Elysées were obliged to close their doors on Tuesday night, in consequence of the failure of the electric light, which was said to be due to the breaking of a cable.

Poplar.—The Board has adjourned consideration of the Committee's recommendation, "That the services of Mr. Morgan Williams, electrical engineer, be engaged to advise the Board on the question of the Board putting in force, within the whole district, the provisional order obtained in 1892, and the probable cost of such a proceeding, and also as to the desirability as an alternative of transferring the order to a public company."

Scarborough.—In commemoration of the Jubilee the brethren of the four Scarborough Lodges of Freemasons have determined to defray the cost (£130) of installing the electric light at the Scarborough Hospital and Dispensary.

Sheffield.—In connection with the Queen's visit to-day, there will be extensive illuminations of the city in the evening. There are to be search lights, triumphal arches, and other features usual to such occasions, and the Sheffield Electric Light and Power Company is very busy preparing.

Sittingbourne.—The District Council have deputed a Committee to consider the substitution of the electric light for gas at the waterworks.

Shoreditch.—The Vestry has concluded an agreement with the Free Wiring Syndicate.

Southampton.—The electrical engineer reports that the output for March was 13,664 units, an increase of 50 per cent. compared with March, 1896. He was instructed to obtain 28 Ferranti meters, and reports that tenders will be invited for the clockwork meters now in use throughout the borough as soon as replaced by the Ferranti meters.

Stafford.—The County Surveyor has reported upon the consumption of electric light and energy at the County Buildings, Judges' House, and Eastgate House during the 12 months ending March 31st, 1897. His statement showed—County Buildings: Total for the year, 5,188 units at 8d. per unit, £172 18s. 8d.; Judges' House: Total for nine months, 1,680 units at 8d. per unit, £56; Eastgate House: Total for six months, 606 units at 8d. per unit, £20 4s. The following scale was adopted for the current year by the Town Council:—Under 2,000 units, 7d. per unit; 2,000 units, under 4,000 units, 6½d. per unit; 4,000 units, under 6,000 units, 6d. per unit; 6,000 units, under 8,000 units, 5½d. per unit; 8,000 units and upwards, 5d. per unit. Consumption to be calculated upon quantity used per annum, and to be charged at middle price, 6d. per unit, during the June, September, and December quarters, any reductions or additions to be made in the accounts for the March quarter, when quantity used during the year has been ascertained.

Sunderland.—We learn from the borough electrical engineer, Mr. J. F. C. Snell, that the Corporation has, upon his recommendation, decided to adopt the "Maximum Demand System" for all future consumers, and any of the present consumers who may desire. They have decided to instal 50 arc lamps in the principal streets of the town, also to extend the mains to the north side of the river. One consumer in that district has applied for 140 H.P. for motor purposes.

Walsall.—The total number of consumers supplied on April 30th was 79. The wages paid during the month amount to £42. The value of coal consumed was £14.

Wandsworth.—The District Board of Works has approved the notice from the County of London Electric Lighting Company of intention to lay conduits on both sides of East Hill, Wandsworth, from the intersection of Alma Road to the boundary of the parish of Battersea; also on both sides of Portinscale Road, Roehampton Lane, Alton Road, Ponsonby Road, Medfield Road and Treville Street, Putney, and to construct a transformer box in Treville Street.

West Ham.—The electrical engineer has reported that as matters stand at present, it was unlikely the accounts for the first year's supply of current would be prepared for two years yet, and when presented, he was afraid they would show the Department in a very unfavourable light, as the establishment charges for the three years will have to be provided for, and the interest and sinking fund, for at least the part of the £50,000 spent this year will be debited against them, while nothing is being earned. It is stated that the installation will not be complete until the autumn of 1898!

We understand from *Daily Tenders* that the Town Council has received the following tenders for the supply and execution of pipe work, feed pumps, feed water tanks, &c.:—Brush Electrical Engineering Company, 49, Queen Victoria Street, E.C., £2,415. Mallett and Co., Laurence Pountney Lane, E.C., £3,094. Thames Iron Works, Blackwall, E., £3,313. The tenders have been referred to committee.

Weston-Super-Mare.—The Lighting Committee has been instructed to take into consideration at an early date the desirability of utilising the electric lighting powers contained in the provisional order obtained by the late Local Board, and retained by the Council.

Whitechapel.—The District Board has declined to accept the terms offered by the County of London and Brush Provincial Electric Lighting Company or the Max-Saturn Electric Syndicate to take over the Board's provisional order, neither of such offers appearing advantageous to the district. The Board, however, appointed a sub-committee to inspect electric lighting stations in London, Brighton, and elsewhere to obtain information.

Willesden.—The District Council have instructed Mr. W. H. Trentham, M.I.Mech.E., consulting engineer, of 39, Victoria Street, S.W., to report as to the best area for electric lighting, and to furnish the Council with an estimate of the capital outlay, together with the probable revenue and working expenses.

Withington.—The Board of Trade has granted the District Council's provisional order.

Yarmouth.—The Surveyor's statement shows that the income for the month for electricity supply was £187 1s. 8d., against working expenditure of £168 10s. 8d., leaving a balance of £18 10s. 8d. to meet capital and sundry charges of £150 per month. An offer from the Great Eastern Railway of £36 per annum for lighting two arc lamps on the approach to Vauxhall Station, has been accepted.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Belfast.—The Belfast Street Tramways Company have lodged with the Clerk of the Privy Council a memorial praying for an order in Council to authorise the construction, maintenance, and working of certain tramways in the counties of Antrim and Down, and in the town of Holywood.

Birmingham.—The House of Commons Select Committee passed the City of Birmingham Tramways Company's Bill on 17th inst. Mr. Alfred Dickinson, M.I.C.E., gave evidence, and referred to the advantage that the district would reap from the electric tramways.

In respect to the disagreement *re* the conduit and trolley systems, we hear that Mr. Pearson, the tramway company's engineer, is now in this country, and will confer with the Public Works Committee next Monday. The Committee hope to report on the subject about the middle of June.

Derby to Ashbourne.—This light railway scheme is still on foot, and the Ashbourne Council has now appointed a committee to consider the plans.

Dublin.—It is stated that the heads of the agreement between the Dublin Corporation and the Tramways Company for increased way-leave, and the substitution of electric traction in specified districts for the existing mode of transit, with certain definite clauses for the protection of the Corporate interests, in the Bill now before Parliament, have been formally settled by the engineer and solicitor to the Corporation on the one side, and the solicitor representing the Tramways Company on the other.

The Dublin Southern District Tramways Company have lodged a memorial to the Lord Lieutenant in Council praying for an Order to authorise the construction, maintenance, and working of certain tramways in Blackrock and Kingstown Townships.

Dundee.—The question of the extension of the tramway systems and the adoption of the best method of propulsion, has been under consideration at the Town Council, and will come up again shortly.

Excess Current Recorder.—As a check upon the amount of current used unnecessarily in starting and running tramcars, Mr. J. R. Cravath, of Chicago—who has hitherto, we think, been associated with one of the American electrical papers—has brought out on the market, and intends to push the development of, a device for showing when, and in what quantity, an excessive current is allowed to pass. The device is ingenious, if not very sensitive and reliable; but, for our own part, we should on the whole prefer a recording ammeter or wattmeter, if the expense of these appliances can be afforded. Even then it seems hardly fair to blame a motorman for every excess of current, unless the fair average required under average conditions for each route shall have been arrived at first. The difficulty of doing this for all conditions of load and track may be imagined; and we very much doubt whether the use of these appliances can ever prove much more than a silent monitor always at hand to get the motorman into a possibly awkward fix, unless he can bring forward—or invent—some good excuse or reason for running so much "juice" through the controller. The use of a system like this, with rewards and penalties, would roughly correspond to the coal premiums of a steam locomotive engine driver; and it is well known that these are not entirely satisfactory to all concerned—shareholders as well as the travelling public. Mr. Cravath's device practically consists of a long thin strip of alloy with its bottom edge resting upon a bare German silver wire carrying the main current. When the latter rises above a certain point, the temperature is raised to a degree that allows the wire to melt its way through the strip which descends by gravity being cut in two, as it were, by the hot wire. Comparative lengths of alloy strips thus cut by the hot wire show for different instruments and cars the various excess amounts of current used, and allow of comparisons being made between the working methods of different motor men. As we have already said, such comparisons can only be made with fairness between cars and operators on the same routes and under similar conditions. In some cases a heavy current must be applied for some time in order to keep time and mount grades; yet the use of such large amounts could not, we think, with the device in question, be differentiated from waste current used at starting and stopping from sheer carelessness. If anything, the former would show more consumption of alloy strip than the latter, because of longer duration in time; yet it is much less worthy of blame. However, the appliance may undoubtedly have a moral deterring influence, just as does the familiar notice in apple orchards, "Trespassers beware! Spring guns set here!" and we shall be interested to hear of further developments by the inventor, who may certainly be complimented upon a cheap, efficient and ingenious substitute for a recording ammeter.

Howth.—The Hill of Howth Electric Tramway Bill was before the House of Lords' Select Committee last week. The promoters' counsel said that it was a Bill of the Great Northern Railway Company of Ireland to make certain tramways and tramroads about 5½ miles in circuit round the Hill of Howth. The estimate of the work was about £39,000. They proposed to work electrically, and further took power to work a branch of the Great Northern Railway line between Sutton and Howth by electricity, so as to have a complete circuit all the way round. The Committee considered the preamble of the Bill proved and that it should proceed.

Motor Cars.—At the monthly meeting of the Leeds Association of Engineers, Mr. J. H. Mann gave a paper on "Auto-Cars." He said that it was not a difficult thing to make a machine that would run on the roads, the difficulty was in making one that would do its work better and cheaper than horses. In order to succeed, simplicity in construction was a prime necessity. As a means of propulsion, electricity could only be used in limited areas, and he thought steam engines met the requirements more completely than oil engines. The Serpollet boiler, or instantaneous steam generator, was a move in the right direction, on account of its simplicity and freedom from danger. He looked forward with keen anticipation to a great future for auto-cars, but at the present time, from a manufacturer's point of view, should not care to put into inexperienced hands a complicated machine, especially with a guarantee for any considerable time.

Motive Power for Weaving.—It appears from a report by Consul Perceval on the trade of Marseilles, that a question widely discussed both in Lyons and St. Etienne is the distribution of a cheap motor power from house to house, and in Lyons there are several companies with large capital engaged in the experiment, still they are not sufficiently advanced to indicate their chances of success; but in St. Etienne the problem appears to be already solved. At the present moment 1,200 looms, of which about two-thirds are situated in the town, and the remainder in the surrounding districts even as far as 30 miles away, are driven by power distributed by the company of St. Victor-sur-Loire. This company, founded in 1893 with 1,000 horse-power, has since that date added already 400 horse-power now working, 1,200 horse-power on the point of being used, and now propose to add another 3,000. The power is transmitted by electricity, the price per loom being 8s. per month, and the time when the loom is not working is allowed for at the rate of 4d. per diem. The production of hand-looms transformed by this system, which entails no alteration to the loom itself, is increased by 25 per cent., and allows many weavers, who were incapacitated from lack of strength, to resume work.

Provincial Tramway Schemes.—Yesterday's *Financial Times* says that the British Electric Traction Company is extending its field of operations. "News reaches us to the effect that the company has acquired the control of two very important tramway systems in the Midlands. The object is, of course, to work these systems by electricity, and it is considered that a substantial saving will thereby be effected in the expenses. Other developments of a similar nature in the near future would not surprise us."

Taunton.—The Town Council has approved of the principle of laying a light electric railway in Taunton by the Taunton and West Somerset Electric Railways and Tramways Company, but the Council reserves to itself the right to go into the question of details with the company later on.

W. E. Trolley Material.—We have before us a copy of the Western Electric Company's catalogue of line material, accessories and supplies for electric tramway work. The particulars as to code words, list numbers, general description, and prices, are arranged in a very business-like manner, and illustrations are given of a great number of the articles, such as suspensions, suspension ears, frogs, crossings, insulators, various kinds of steel and iron poles, flexible brackets for ditto, feed arms, clamps, trolley wheels, the Bryant S.P. railway switch, Perkins railway switches, cleats, car lighting accessories, and various other apparatus connected with tramways and tramway work.

TELEGRAPH AND TELEPHONE NOTES.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired
Brest-St. Pierre (Anglo, 1869)	April 6th, 1895 ...	...
West Indies—		
Puerto Plata-Martinique	Dec. 19th, 1895 ...	...
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Jamaica-Colon	Feb. 6th, 1897 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Konakry-Sierra Leone ...	April 28th, 1897 ...	...
Para-Maranham	May 5th, 1897 ...	...
Landlines.		
Trans-Continental line beyond Mazol	March 12th, 1896 ...	...
Carthagena - Barranquilla (Columbia)	July 4th, 1896 ...	...
Moulmein-Bangkok ...	... May 5th, 1897 ...	...
Saigon-Bangkok ...	... May 17th, 1897 ...	May 18th, 1897.

April 19th, 1897.—Chio-Syra route impracticable.

April 19th, 1897.—During war between Turkey and Greece, cable between Trieste and Corfu cannot be used for messages for Turkey; they must be sent *vid* Bosnia, Montenegro and Servia.

The Ottoman Government announces that messages in secret language may not be sent to the Greek Minister and Consul in Turkey. They are to be in plain language.

April 21st, 1897.—Greek Administration prohibits secret language for private telegrams for Greece.

April 25th, 1897.—The Hellenic administration notifies delay on press messages emanating from Greek provinces by reason of the lines being blocked.

New African Cables.—The Berlin correspondent of the *Standard* says that the Mozambique Company and the Compagnie Industrielle d'Orient have opened negotiations for the conclusion of a contract for laying a cable from Beira to Europe. It is also rumoured that the Compagnie Industrielle intends to erect a telegraph line from Beira to the frontier of the South African Republic. It is hoped in Lisbon that the Transvaal will share a large portion of the cost, and provide a good deal of the capital. The fact that Germany has abandoned the idea of connecting her Protectorate with the Cape telegraphs has suggested a plan in Portugal for laying a wire from Swakopmund to Mossamedes, in the Province of Angola, where there is a cable terminus station. This proposal will be accepted by Germany, as she can thereby obtain a land telegraph station in South-West Africa without coming in contact with the English. "This news clearly proves," says the *Hamburgische Correspondent*, "that the present Portuguese Government is not in the least inclined to yield to English wishes and demands as regards South Africa."

Telegraphic Extension Guarantees.—In the Commons last week Mr. P. O'Brien (Kilkenny) asked the Chancellor of the Exchequer whether the proposed reductions in the guarantees for telegraphic extension would be made retrospective to relieve guarantors in places where telegraph offices had not paid working expenses.—Mr. Hanbury: The concession to be made will apply to existing guarantees. The form which the concession takes is that the Exchequer will share the loss, if any, equally with the guarantors. It will come into operation on Jubilee Day, and will from that date apply to both future and existing guarantees.

CONTRACTS OPEN AND CLOSED.

OPEN.

Bedford.—June 8th. The Urban Sanitary Authority want tenders for the supply and erection at the sewage pumping works of two alternating current motors coupled direct to two vertical spindle centrifugal pumps. See our "Official Notices" for particulars.

Belfast.—June 3rd. The Electric Committee want tenders for the supply and erection of switchboard, instruments and connections, also a motor-generator and boosters. See our "Official Notices" for particulars.

Bilston (Staffs.).—May 24th. The District Council are inviting tenders for the supply up to March 31st, 1898, of electric light plant. Particulars at the Clerk's Office.

Bray.—June 7th. The Township Commissioners want tenders for the supply of electrical and other stores, including carbons, cables, switches, lamps, holders, fuses, &c., during twelve months. Particulars from the Town Clerk (Mr. P. MacDonnell), at the Town Hall.

Brazil.—June 30th. Tenders are being invited until June 30th next by the Municipal Authorities of Rio de Janeiro for the establishment of a telephone exchange in the city. Particulars of the contract were published in *Daily Tenders and Contracts* for May 6th.

Chili.—June 19th. The General Direction of the Chilian Telegraphs in Santiago is inviting tenders for the supply of a quantity of galvanised iron wire, insulators, Morse telegraph apparatus, &c.

Dingwall.—May 22nd. The Burgh Council is prepared to consider proposals from persons or companies willing to undertake the free electric lighting of this town. Particulars from Mr. A. Hill, Hillhouse, Dingwall, the Council's electrical engineer.

France.—May 25th. The General Direction of the French Post and Telegraphs in Paris is inviting tenders for the supply of a quantity of telegraph and telephonic apparatus. Tenders to the Sous-Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle, 103, Paris.

Huddersfield.—June 1st. The Electric Lighting Committee are inviting tenders for the supply and erection of two steam boilers for the electric light station. Borough Electrical Engineer, Mr. A. B. Mountain. See our "Official Notices."

Roumania.—August 20th. Tenders are being invited by the General Direction of the Roumanian Posts and Telegraphs in Bucharest for the supply of 55,000 porcelain (double-bell) insulators. Tenders to be directed to the Direction Générale des Postes et des Telegraphes, Bucharest.

Spain.—June 8th. The Spanish Ministry of Public Works in Madrid is inviting tenders for the concession for a projected electric tramway between Barcelona and its suburbs. Tenders to the Direccion Generale des Obras Publicas, Madrid.

Spain.—May 30th. The Municipal Authorities of Osuna (Seville province) are inviting tenders for the concession for the electric lighting of the town during a period of 13 years. Tenders to be sent to El Secretario del Ayuntamiento de Osuna (Seville province.)

Spain.—Tenders are also being invited by the Municipal Authorities of Almazan (Soria province) for the concession for the electric lighting of the town during a period of five years. Tenders to be sent to El Secretario del Ayuntamiento de Almazan (Soria).

Sunderland.—May 26th. The Corporation is prepared to receive tenders for a high-speed three-crank steam dynamo. Particulars from Mr. J. F. C. Snell, the Borough Electrical Engineer.

Sweden.—June 8th. Tenders are being invited by the Stockholm Gas Works Authorities for the supply and erection of a 500 H.P. triple-expansion engine required in connection with the central electric lighting station. Tenders to be addressed to the chief engineer, Herr Ad. Ahlsell, Stockholm Gaswerk, Stockholm.

Wakefield.—June 2nd. The Wakefield Board of Guardians want tenders for the following work for the new infirmary:—1. Electric lighting plant, combined steam engine and dynamo, belt-driven dynamo, motor dynamo, motor, switchboards, storage cells, &c.; 2. Complete system of wiring for the electric light, also bells and telephones; 3. Vertical steam engine, feed water heater, tank, pumps and pipe work, &c. Particulars from Messrs. Shepherd & Watney, engineers, 71, Albion Street, Leeds.

CLOSED.

Aberdeen.—In regard to the list of tenders which we reproduced from *Daily Tenders* last week, Messrs. Veritys think some little explanation is required to explain the apparent divergence in the figures for the set of battery regulating switches for Aberdeen. They state that the list is obviously wrong. "The specification was for one main battery switch for which we quoted but the quantity to be supplied was two switches. All the other contractors appear to have given their price for the double switch."

Bradford.—The contract for the reconstruction of the refuse destructor has been given to the Horsfall Furnace Syndicate at £1,200. Messrs. Thwaites Bros., Limited, will do certain work on boilers at the electric light station for the sum of £905.

Nottingham.—Messrs. R. Hornsby & Sons, Limited, have received an order for two "Hornsby" water-tube boilers of 75 H.P. each, through the Engineer-in-Chief to the General Post Office and Telegraphs, for erection at the Post Office, Nottingham.

NOTES.

300 H.P. Steam Turbine.—The *Scientific American* recently contained a description of a 300 H.P. De Laval steam turbine which is running very successfully at the Twelfth Street station of the Edison Electric Illuminating Company, New York City. The steam is led into a circular steam-tight casing in which is located the turbine wheel. This wheel has a diameter of 29½ inches, and runs at 9,000 revolutions per minute, the speed of the buckets being 1,160 feet per second. The blades are arranged, says the *Engineer*, around the periphery and are milled out of the solid steel spokes with which the wheel is built up. They are made very thin at the edges and are of a curved cross section. A steel band is left on around the periphery, in order to prevent the steam from passing out over the ends of the blades; and it also serves to oppose the tendency of the turbine to act as a fan. The steam enters the turbine at a pressure of 147 lbs., and is directed upon the wheel by means of eight nozzles. These nozzles are inclined to the sides of the wheel at an acute angle, and the face of the nozzle which lies opposite the line of the buckets is bevelled to match the angle so formed. The centre of gravity of the wheel and the axis of the shaft upon which it turns are never exactly the same. To overcome the difficulty the wheel is mounted upon a long flexible shaft, so that when the turbine is running at high speed the wheel revolves on its true centre of gravity, the axis of the shaft springing sufficiently to allow this adjustment to take place. The turbine shaft extends into a cast-iron gearing box, where it carries a pinion whose teeth are helicoidal and are inclined at an angle of 45° in opposite directions. This pinion operates two toothed wheels, whose gearing is also helicoidal, which are placed symmetrically on each side of the pinion. The shafts of these two gears extend through the gearing box and operate two Desrozier 100-kilowatt dynamos which are connected on the three-wire system. The proportion of the gearing is such that the speed of the dynamo is reduced to 750 revolutions per minute. The regulation of the turbine is effected by means of a centrifugal governor which is driven from the shaft of the larger gear wheel. The segment weights or wings of the governor are movable on knife edges with very little friction. When the governor revolves the weights diverge, their inner ends rush a pin forward, this pin in turn causing the cut-off of the steam through the movement of the balanced valve in the steam supply pipe at the top of the turbine. A spiral spring inclosed in the governor keeps the weight in a state of equilibrium at a speed of 750 revolutions.

Stockholm Exhibition.—On the 15th inst. a Scandinavian Industrial and Art Exhibition was opened at Stockholm by King Oscar in the presence of a brilliant assembly. This exhibition is held in connection with the commemoration of King Oscar of Sweden and Norway's 25 years' jubilee, and promises to be a great success. It is arranged on a large scale, and besides Sweden, Norway, and Denmark, which are very well represented, there is also a small Russian Exhibition attached. We hope later on to give some particulars of the electrical, telegraphic, and telephonic exhibits. In the meantime we notice in the Danish division a very complete and interesting collection of instruments, as used by the Great Northern Telegraph Company and manufactured in the company's own works at Copenhagen, viz.: a submarine cable station fully equipped with instruments for working the company's cables, a complete set of testing instruments for a cable house or cable steamer, and a display of special instruments for working and testing purposes. This company also exhibits samples of its several types of cable, different kinds of cable and core faults, and on the walls are painted large maps of Europe and Asia, showing in a decorative manner the company's cables and lines from London to Japan, China, and Hong Kong *via* the north of Europe, Russia, and Siberia.

Liquid Air.—At the Royal Institution, on Thursday last week, Prof. Dewar gave the last of his course of lectures on "Liquid Air as an Agent of Research," with a short discussion of the limiting volume of substances at the zero of absolute temperature. It was impossible, he said, to believe that matter at that temperature would have no mass, and the extension by extrapolation of the curves expressing variations of density at attainable temperatures might give entirely wrong results, because at low temperatures many properties of bodies dropped, as it were, over a precipice. The lecturer, says the *Times* report, then illustrated by experiments the changes produced in the elastic constants of various substances by intense cold, and proceeded to discuss chemical action at low temperatures. All ordinary reactions entirely ceased, largely because everything became solid—a state of matter not favourable to chemical action. Photographic action, however, persisted to a certain extent, particularly if gelatine plates were used. This might probably be explained as indirectly due to the property possessed by organic bodies, especially the more complex ones, of phosphorescing at low temperatures. Prof. Dewar also showed how cold increased the magnetic moment of a permanent magnet by as much as 20 or 30 per cent., and at the same time illustrated the magnetic properties of liquid air itself. In conclusion he referred to the effects of extreme cold upon living organisms. In the case of ordinary putrescent matter it was found that the spores were not killed by being subjected to the temperature of liquid air, and experiments were now being carried out to discover whether seeds exposed to liquid air for at least 100 hours still retained the power of germination.

The Institution Conversazione.—The *conversazione* of the Institution of Electrical Engineers will be held at the Natural History Museum, Cromwell Road, S.W., by permission of the trustees, on Tuesday evening, June 15th, from 9 o'clock to 12 o'clock. The President (Sir Henry Mance) and the Council are now issuing the invitations.

Sir John Pender Gold Medal.—The International Submarine Telegraph Memorial Committee, of which the Marquis of Tweeddale is the chairman, has granted "The Sir John Pender Gold Medal," value £5 5s., to the Glasgow and West of Scotland Technical College. It is given annually to the best student who at the same time obtains the College diploma in electrical engineering. At the end of this session, which terminated last week, it was awarded to Mr. David Robertson, Glendale, Uddingston. The origin of this medal was due to the fact that Sir John Pender, when a young man, gained the £5 5s. gold medal for the best design in tapestry in the Old Technical Institution of Glasgow in Session 1835-36, and he gave for upwards of 10 years a medal annually to Prof. Jamieson to be presented to the best student of his electrical engineering classes.

Metric Weights and Measures.—Mr. Emerson Dowson, who is chairman of the executive committee of the New Decimal Association, is reported in the Chamber of Commerce *Journal* as giving an address on the Metric System before the London Chamber of Commerce. Now we don't mind the advocates of the system doing their best for their pet system. Let them be consistent. They have a stock argument that Englishmen are hampered when selling to the foreigner because of the difference of systems. It is the seller who suffers presumably, because the man who has the money—who is parting with the medium of exchange can usually dictate terms to the seller of goods which have no general exchange value. It is very usual to hear the holder of goods exclaim, Are not my things as good as your money? This is a fallacy. Goods cannot be equal to money, for they possess only a partial power of exchange. We all want money because with it we can purchase anything there may be for sale. We don't all want a lathe or a dynamo, and no man ever pays for a dynamo unless he has a use for it, or thinks he can sell it at a profit. The argument is, therefore, a sound one that the seller of goods is liable to be at a disadvantage in selling English measure goods to metric system countries. Yet Mr. Dowson, to make out as much for his hobby as possible, quotes Mr. F. Debenham to the effect that foreigners will now quote to Englishmen in English measures, but that the cost of conversion is charged against the buyer. In other words, the foreigner's desire for sound English money is less than the Englishman's desire for foreign money, and be he buyer or seller, the Englishman pays for the conversion. This is a sample of the one-sidedness of the adherents to the newer system. The only merit possessed by the metrical system is that, as stated by Mr. Siemens, it is the same system as the system of counting. The genius who invented arithmetic—did such an one exist, though we doubt if the art of arithmetic had so Minerva-like an origin, suspecting that, like Topsy, it growed—based his notation on 10. Mr. Dowson describes Herbert Spencer as a strange opponent, because he argues against 10 as the base of notation. Why does the effete English system endure? Simply because it is largely duo-decimal, and there can be little doubt that were the base of numbers to be 12 instead of 10, the change would be very beneficial, and Mr. Siemens argument would indeed have weight. We have no liking for a divorce of measures from the arithmetic base. Also, we dislike the base upon which our metrical friends would place all our measures. Why not reform things altogether in one swoop? In one thing we do agree with Mr. Dowson, and this is in his insistence upon the change being made, when it is made, compulsory. If permissive, as in the U.S., it never will be made here any more than there. It must be compulsory, and it ought to be concurrent with a compulsory change in the United States. We have seen for some years great outcries in many directions. "Made in Germany" did as much harm as good, for it stopped a good deal of merchant business *viâ* London. Introducing the metrical system may open an easier door for foreign competition at home and colonially. But to see both sides of a question is not, apparently, within the mental scope of either Mr. Dowson or other metrical advocates.

Royal Society Candidates.—In the list of 15 candidates who have been selected by the Council of the Royal Society to be recommended for election into the society this year, we observe the name of only one gentleman connected with electrical science. We refer to Mr. Frederick T. Trouton, Sc.D. (Dubl.), M.A., who is assistant professor of natural philosophy and teacher of experimental physics in the University of Dublin.

The Royal Society.—Yesterday afternoon, the Bakerian Lecture was delivered by Prof. Osborne Reynolds, F.R.S., and Mr. W. H. Moorby, on "The Mechanical Equivalent of Heat."

Honours for English Scientists.—The University of Toronto has decided to confer the degree of LL.D. upon Lord Lister, Lord Kelvin, Lord Rayleigh, and Sir John Evans.

Cricket.—A well-contested match was played on Saturday last at Dulwich, on the grounds of the Telephone Athletic, against the Joel-Pilsen C.C., which resulted in a win for the former by six runs. Great interest was sustained to the finish.

Lectures.—Mr. James Swinburne, M.Inst.C.E., M.I.E.E., will commence a course of lectures to the senior students of the Electrical Standardising, Testing, and Training Institution upon "Dynamo and Transformer Construction" on Tuesday, June 1st.

Royal Institution.—The Friday evening discourse at the Royal Institution next week (May 28th) will be delivered by Prof. H. Moissan (Directeur Laboratorie de Chimie Minerale a l'Ecole Superieure de Pharmacie, Membre de l'Academie des Sciences, Paris), who will lecture in French on "The Isolation of Fluorine" (with experiments). On Friday, June 4th, Mr. W. H. Preece, C.B., F.R.S., will lecture on "Signalling through Space without Wires." On Friday, June 11th, Mr. William Crookes, F.R.S., will deliver the last of the Friday evening discourses for the year. His subject will be "Diamonds."

Institution of Electrical Engineers.—The next students meeting will be held at 28, Victoria Street, S.W., on Wednesday, May 26th, at 7.30 p.m., when a paper will be read on "The Working of Long Submarine Cables," by Messrs. R. M. Sayers and S. S. Grant, Students I.E.E.

Electric Lighting of the Berkeley Hotel.—This well-known and old established hotel has undergone considerable alterations and renovation, besides being considerably enlarged by the addition of a new portion to the Piccadilly front. The whole of the electric lighting work has been carried out by Messrs. Strode & Co. The wiring in the basement of the building is on the conduit system, while the remainder of the building is wired in wood casing. There is no special novelty in the work except in the elegant fittings, which throughout the building are of Messrs. Strode's own design and manufacture. Those in the restaurant and entrance hall are Jacobean in style, and are made in polished bright iron, the reception room being fitted with handsome gilt Louis XIV. candle sconces. The same firm have also supplied and fixed two vertical steam boilers, which are not only the means of supplying steam for all the cooking apparatus, and for heating purposes, but by an ingenious automatic arrangement, provide a hot water supply for the hotel of over a 1,000 gallons per hour if required. The kitchen provides a novelty in the shape of a spit which is driven by an electric motor. There are altogether 900 lights in the building, and these are arranged on two sides of a three-wire system brought from the street mains, having a difference of potential of 400 volts between the two outers.

Marconi Telegraphy.—The Post Office Telegraph authorities have during the past fortnight been making a series of very interesting experiments with Signor Marconi's system of telegraphy without connecting wires, in the Bristol Channel. Experimental stations have been established at Lavernock Point, near Penarth; on the Flat Holmes, an island in mid-channel, and at Brean Down, a promontory on the Somerset side. We understand that satisfactory signals have been obtained between the first and last-named points, a distance of, approximately, eight miles. Signals were also exchanged between Lavernock Point and the Flat Holmes. The receiving instrument used was a Morse inkwriter of the Post Office pattern.

Conversazione.—On Wednesday, last week, a *conversazione* of the Leathersellers' Company was attended by a number of eminent scientists, including Sir Frederick Bramwell, Sir F. Abel, Sir Douglas Galton, Mr. J. Wolfe Barry, C.B., &c. Prof. Hughes, Dr. Gladstone, and Profs. Boys Thompson, Fleming and Ayrton. Prof. Ayrton explained some of the principal discoveries in relation to submarine and duplex telegraphy. Prof. S. P. Thompson explained the Röntgen ray and other apparatus. Prof. Roberts-Austen showed an electrical furnace in operation, and there was a demonstration in electric cooking.

Mr. Verity's Approaching Marriage.—A dinner was given last Friday in the Louis XV. room at the Hotel Cecil by the directors and heads of departments of Veritys, Limited, to Mr. John Verity, chairman of the company, on the occasion of his approaching marriage. The chair was taken by Mr. J. Elwin-Coles.

Appointment.—The Hackney Vestry have completed the lighting of the Public Baths, and the Town Hall is shortly to be supplied by a separate plant. Mr. R. W. Hawley, of the Electric Light Department, General Post Office, has been appointed to the post of electrician.

Electrozone for Calcutta.—It is stated by an Indian paper that the British Electrozone Corporation, Limited, of London, is preparing plant for the manufacture of this powerful disinfectant for the Municipality of Calcutta. The cost is £5,000.

Appointment Vacant.—Mr. Vincent Kitchener having accepted another position in the service of the British Electric Traction Company, Limited, has resigned the appointment of secretary, and as will be seen from our "Official Notices," the company invites applications for the secretaryship.

Copper.—Copper deliveries in the past fortnight of May amounted to 6,690 tons, and as the supplies were only 5,633 tons, the statistical position has been improved, though not to such an extent as to confirm the expectations of those who are predicting another "corner" in copper. The visible stocks are 32,736 tons—a decrease of 1,057 tons since the beginning of the month. Of the supplies, no less than 4,157 tons, or over 73 per cent., came from America. If there is to be a copper famine, it will not be the fault of the United States.—*Financial News.*

Telephone Facilities.—It will be seen, from a notice published in another column, that our telephonic facilities are being gradually brought into accord with those of other countries, arrangements having now been concluded whereby subscribers to certain metropolitan exchanges can send messages by telephone which can be forwarded by the Post Office either as telegrams, express letters, or ordinary letters. An express messenger may also be obtained by a telephonic request. It will be interesting to see how these facilities are taken advantage of by telephone subscribers.

NEW COMPANIES REGISTERED.

Corbidge Electric Lighting Company, Limited (52,491).—Registered May 12th, with capital £4,000 in £5 shares, to carry on at Corbidge and elsewhere in Northumberland the business of electricians, electrical and mechanical engineers, suppliers of electricity, &c. The subscribers (with one share each) are:—T. G. Usher, Stocksfield, electrical engineer; A. Balkwell, Monksholme, Corbidge, solicitor; W. Ferguson, Edenhurst, Corbidge, contractor; A. W. Price, Wellbank, Corbidge, chartered accountant; W. White, Eastrigg, Corbidge, engineer; C. F. Armstrong, Peel Tower, Corbidge, architect; D. Stephens, Ravenstone, Corbidge, shipowner. The number of directors is not to be less than three nor more than five. The first are H. S. Edwards, C. F. Armstrong, W. Ferguson, and T. G. Usher (managing director). Registered by Satchell & Chapple, 6, Queen Street, Cheapside.]

White, Jacoby & Co., Limited (52,494).—Registered May 12th with capital of £4,000 in £1 shares, to acquire and carry on the business of electrical and mechanical engineers, carried on at 54, Bayham Place, Camden Town, as "White, Jacoby & Co.," and to adopt a certain agreement. The subscribers (with one share each) are:—F. W. White, 120, Albert Street, N.W., engineer; W. C. Seaton, Gowan Bank, Leigh, Essex, surveyor; H. C. E. Jacoby, 20, Ashby Road, Canonbury, N., electrical engineer; W. J. B. Odhams, North Hill, Highgate, N., printer; E. C. Leachman, 9, Woodview Gardens, Highgate, paper manufacturer; R. A. Long, Southwood Lodge, Highgate, clerk; L. F. A. Whitmore, 17, Scarsdale Villas, Kensington, clerk. The number of directors is not to be less than three nor more than five; the first are F. W. White (managing director), H. C. E. Jacoby, and J. A. de Morgan; remuneration £20 per annum, divisible. Registered by Jordan & Sons, Limited, 120, Chancery Lane, W.C. Registered office, 54, Bayham Place, Camden Town, N.W.

Accumulator Syndicate, Limited (52,514).—Registered May 13th with capital £30,000, in £1 shares, to manufacture, sell and deal in batteries, accumulators, and cells, and to carry on the business of electricians, engineers, machinists, fitters, founders, &c. The subscribers (with one share each) are:—H. R. Leach, Chichell Road, Cricklewood, director; A. J. Leese, Wellesley Road, Snaresbrook, secretary; F. Sidney, 98, Sewardstone Road, Victoria Park, N.E., clerk; A. North, 2, Church Court, Clement's Lane, E.C., clerk; O. L. Richardson, 113, Roman Road, Barnsbury, clerk; J. H. Ireland, 2, Westrop Villas, Canonbury Street, N., clerk; E. Howard, 15, Abchurch Lane, E.C., gentleman. The number of directors is not to be less than three, nor more than five; the subscribers are to appoint the first. Qualification £100; remuneration £150 each per annum. Registered by W. T. Hick, 2 Church Court, Clement's Lane, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Telegraph Construction and Maintenance Company, Limited (11,470).—This company's annual return was filed on March 24th, when the whole capital of £448,200 in £12 shares was taken up and paid for in full.

W. T. Henley's Telegraph Works, Limited (13,795).—This company's annual return has just been filed. The whole capital of £130,000 in £10 shares (of which 3,000 are preference) has been taken up, and paid for in full.

Eastern Telegraph Company, Limited (63,380).—This company's annual return has just been filed. The capital is £4,700,000 in £10 shares (of which 70,000 are preference); 469,989 of these have been taken up, and the full amount has been called and paid.

Anglo-American Telegraph Company, Limited (28,910).—This company's annual return was filed on April 9th. The capital is £7,000,000 stock, fully paid.

City of London Electric Lighting Company, Limited (34,406).—This company's annual return was filed on April 12th. The capital is £1,200,000, in £10 shares (of which 40,000 are preference). All the preference and 47,976 ordinary have been taken up, and £10 per share has been called on 40,000 of each class, while £2 per share has been called on 7,976 ordinary, resulting in the payment of £815,952.

Birmingham Electric Supply Company, Limited (30,296).—This company's annual return was filed on March 29th, when 30,000 shares were taken up out of a capital of £200,000, in £5 shares; £150,000 has been called and paid.

Altrincham Electric Supply, Limited (40,795).—This company's annual return was filed on April 5th, when 25,000 shares were taken up out of a capital of £50,000 in £1 shares. The full amount has been called, and £25,000 paid.

Hove Electric Lighting Company, Limited (36,942).—This company's return was filed on March 22nd, when the whole of the capital of £40,000 in £5 shares was taken up; £5 per share has been called on 7,384, £3 per share on 80, and £2 per share on 536, resulting in the payment of £38,307, which includes £75 received in advance of calls.

Mexican Gas and Electric Light Association, Limited (18,223).—This company's annual return was filed on April 28th, when the capital of £100,000 in £20 shares was considered as fully paid.

National Telephone Company, Limited (15,066).—This company's annual return was filed on April 2nd. The capital is £4,000,000, in 15,000 first preference of £10, 15,000 second preference of £10, 250,000 third preference of £5, and 490,000 ordinary shares of £5 each. All the first and second preference, 119,234 third preference, and 484,597 ordinary have been taken up, and 28,284 third preference and 44,413 ordinary are considered as paid. The full amount has been called on the rest, and £2,955,670 paid.

Eastbourne Electric Light Company, Limited (16,422).—This company's annual return was filed on April 5th, when 1,949 shares were taken up out of a capital of £50,000 in £10 shares; £10 per share has been called, and £19,490 paid.

British Blahnik Arc Light Company, Limited (50,080).—This company's statutory return was filed on March 27th, when 27,000 shares were taken up out of a capital of £50,000, in £1 shares; £1 per share has been called, and £24,107 16s. 8d. has been paid, leaving £2,892 3s. 4d. in arrears.

Pontypool Electric Light and Power Company, Limited (36,109).—This company's annual return was filed on March 23rd, when 1,143 shares were taken up out of a capital of £10,000, in £5 shares; £5 per share has been called on 669, and £4 per share on 474 shares, and £5,241 has been paid.

Dover Electricity Supply Company, Limited (39,779).—This company's annual return was filed on April 23rd, when 4,860 shares were taken up out of a capital of £50,000, in £5 shares; £5 per share has been called, and £24,280 has been paid, leaving £20 in arrears.

Sheffield Electric Light and Power Company, Limited (36,351).—This company's annual return was filed on April 22nd, when 12,104 shares were taken up out of a capital of £280,000 in £7 shares; 4,000 have been issued with £5 per share considered as paid; £5 per share has been called on £8,104, and £2 per share on 4,000, resulting in the payment of £48,578, including £68 paid in advance of calls.

Oxford Electric Company Limited (34,685).—This company's annual return was filed on April 9th, when 8,000 shares were taken up out of a capital of £100,000, in £5 shares, and the full amount called and paid.

County of London and Brush Provincial Electric Lighting Company, Limited (34,320).—This company's annual return was filed on May 3rd. The capital is £800,000, in £10 shares (40,000 preference), and 20,000 preference and 22,475 ordinary have been taken up, £10 per share has been called, and £424,720 has been paid, leaving £30 in arrears.

Anglo-Portuguese Telephone Company, Limited (24,545).—This company's annual return was filed on April 15th, when 50,000 shares (all of which are considered as fully paid), were taken up out of a capital of £75,000 in £1 shares.

Edison Gower-Bell Telephone Company of Europe, Limited ((16,010).—This company's annual return was filed on April 15th, when 385,009 shares were taken up out of a capital of £500,000, in £1 shares; 370,000 of these are considered as paid, and £15,009 has been paid on the rest.

Direct Spanish Telegraph Company, Limited (6,732).—This company's annual return was filed on April 24th, when 12,931 ordinary and 6,000 preference shares were taken up out of a capital of £95,000 in £5 shares. £5 per share has been called, and £94,655 paid.

CITY NOTES.

Glasgow Electric Wire and Rubber Company.

This company has been formed with a share capital of £50,000, divided into 5,000 6 per cent. cumulative preference, and 5,000 ordinary shares of £5 each, of which the whole of the preference shares, and 1,000 of the ordinary shares, are now offered to the public, the remaining 4,000 ordinary shares being taken by the vendor. The objects of the company are to acquire the fixed plant, machinery, tools, and stock-in-trade of the United Gutta Percha and Rubber Company, situate in the Craigpark Works, Townmill Road, Glasgow, to acquire the benefit of certain inventions relating to improvements in machinery for covering electric wires, and for fire-proof protection for insulating wires and cables, and to acquire a secret process for the manufacture of golf balls, which, it is stated, are being extensively sold under the trade name of the St. Andrew "Golf Ball."

For these advantages the company are to pay £30,000, payable as to £20,000 in fully paid ordinary shares, £7,500 in cash, and the remainder in a manner optional to the directors.

Three reports setting forth the value of the properties have been given by Mr. John Bennie, of the Star Engine Works, Glasgow, Mr. W. A. Phillips, of 85, Gracechurch Street, E.C., and Messrs. Muller and Co. It is necessary to mention, however, that Mr. John Bennie is one of the directors of the company and Mr. Phillips appears to have some contract with the company, and this fact might raise a little prejudice in the minds of investors. The prospectus states that considerable orders for wires and cables can be obtained through the various firms and undertakings in which the directors are interested and no doubt this is a perfectly reasonable statement, but we do not quite see why much importance should be attached to the "remarkable fact that there never has existed in Scotland a manufactory turning out suitable electrical wires and cables," and that "Scotch orders have to be sent to English companies which at present hold the field in Scotland." It ought not to be necessary to say that the company should not rely too far on the patriotism of Scotchmen in matters of business, and it should not be forgotten that there are no duties on English goods sent over the Scottish borders. The profits are estimated to admit of a 20 per cent. dividend on the ordinary shares, but we are afraid this will scarcely be realised. Nor do we see what advantage accrues from quoting the present price of shares in companies such as the Telegraph Construction and Maintenance Company, Limited, the India-Rubber Company, and the British Insulated Company, for in spite of the prospectus, these companies can scarcely be said to be carrying on similar operations. There is a marked absence of information as to the former profits of the old concern, the only tangible figure being the £7,000, the reputed value of the plant.

Tunbridge Wells Accounts.

It is very satisfactory to find that the Tunbridge Wells Corporation Electricity Works should have proved to be so conspicuously successful after eighteen months' working. The net result of the twelve months' operations ending March 31st are that after paying interest on borrowed money (£742 11s. 6d.) and £671 17s. 4d. for redemption of stock, there is an available profit for the year of £890 15s. 8d., which if £737 13s. 7d. surplus at the end of March, 1896, be added, makes the present available surplus £1,628.

This is all very creditable, and we question whether any town on any system could show much better results in so short a time. Coal figures a little high, but it may be expected that with the use of a condensing system, which we understand has been lately put down, there will be a speedy reduction in this item. We can sincerely congratulate Mr. Boot, the Borough electrical engineer, on the success that he has achieved with the Tunbridge Wells system.

The following table gives the cost per unit:—

	1896.	1895.
Total capital expended	£23,923	—
Number of units sold	174,053	—
Number of lamps connected	14,000	—
Revenue from sale of current	£4,148	—
Net revenue	£2,138	—
Average price obtained per unit	5·9d.	—

Cost of production.	£ s. d.	Per unit.
Coal	1,008 0 0	1·38d.
Oil, waste, water, and engine room stores	59 0 0	·08d.
Salaries and wages at generating station	430 0 0	·59d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	105 0 0 (Works' cost 2·19d.)	·14d.
Rates and taxes	78 0 0	·11d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	358 0 0	·49d.
Depreciation of buildings and plant account	—	—
Renewal fund account	—	—
Total	2,038 0 0	2·79d.
Not included in above.		
Public lamps	83 0 0	
Private works	363 0 0	
Total	£2,484 0 0	

Revenue.	£ s. d.	Average price obtained per unit.
By sale of current	4,148 0 0	—
Meter rents	115 0 0	—
Sale of lamps	—	—
Total	£4,263 0 0	—
Not included in above.		
Private works	375 0 0	
Total	£4,638 0 0	

Total cost per unit (exclusive of depreciation and renewal accounts), 2·79d.; works' cost, 2·19d.

Western and Brazilian Telegraph Company, Limited.

The ordinary general meeting was held on Friday, at Winchester House, Lord Richard H. Browne presiding.

After expressing regret at the absence through ill health of the chairman of the company (Mr. W. S. Andrews), and expressing a hope that that gentleman might soon be enabled to resume his ordinary duties, the chairman stated that the receipts of the company for the half-year to December 31st last had been £71,315, or about £9,000 less than those of the corresponding period of 1895. There had been a decrease in their local traffic of £4,960 and of £4,196 in the international traffic. Their cable between Rio and Bahia was down for about four weeks in September. The cable there was doubled, but both cables were simultaneously interrupted. They also had several interruptions in the northern stations between Pernambuco and Para. A further increased loss on exchange had been sustained by them; and no dividend was paid on the shares held by them in the Platino Company, whose system was practically a continuation of this company's. At the corresponding period of last year they received a dividend on their Platino shares of £4,618. This loss was owing to the same causes that had interrupted their own traffic. They had also suffered from the disturbances in

Uruguay; and very severe competition prevailed in the land lines. He did not, however, think that the outlook of the company was altogether as bad as these losses might indicate; in fact, he thought they had cause for a certain amount of encouragement. There had been so far this year an improvement of over 50 per cent. in the receipts of the Platino Company as compared with those for the corresponding period of 1896. The increase shown in their working expenses was £38, but the total expenses of the half-year included £3,570 on account of the hire of the steamship *Buccaneer*. This was purely an exceptional item, owing to the necessity of their own repairing ship, the *Norseman*, having to undergo a complete overhaul. The debenture reorganisation scheme did not come into their accounts this year, although he thought that it affected them to some extent. They had created £400,000 of 4 per cent. debenture stock, which was more negotiable and more easily handled than debentures. As long as any of the debentures remained outstanding, they would have to continue the annual drawings until the whole amount was extinguished, but these drawings would entail no extra expense on them. There was a balance of £4,935 at the credit of the redemption debenture fund, but, there being no further requirement for this, they proposed to transfer it to the reserve fund. The balance to the credit of the revenue account was £36,684, including the amount brought forward from the previous year. The debenture interest for the half-year absorbed £10,671; they had placed £5,000 to reserve, and they now recommended a dividend of 3s. a share, making a total payment of 6s., or 2 per cent., for the year, leaving £6,405 to be carried forward. Their loss in exchange for the past year was £39,300 on the Western and Brazilian lines and £23,038 on the Platino lines, making a total of £62,338. Had there been no loss in exchange they would have had this sum in addition to what they now had available for distribution, and they would have been able to transfer £3,000 or £4,000 more to reserve, and to pay a further dividend of 4 per cent., making 6 per cent. for the year instead of 2 per cent. He believed that the company was managed with every possible economy, and that the real reason why they were not receiving a dividend of 6 per cent. was one which was entirely beyond their control—the price of gold in South America. In the year 1889 exchange with Brazil was 27d. to the milreis, but it had steadily gone down since, and in 1896 the average exchange was only 8⅜d. This decline corresponded very much with their dividend of 2 per cent. in comparison with one of 6 per cent. At the present time, exchange was only 7½d., and with a country like Brazil, he should not like to commit himself to any statement as to what it might be in the future. There was no change in the position of affairs between the Government of Brazil and the company as to the purchase of their cables. As regarded their prospects for the current year, much depended on whether they would have their cables interrupted or not. They had one interruption at the present time, but it was not serious, and if they had no serious break during the year there would be, as far as they could see, a considerable increase in their traffic, and they would also have the saving on the *Buccaneer*. On the other hand, there was the question of exchange, and therefore he did not care to make any estimate or prophecy as to the result of the current year's working. He concluded by moving the adoption of the report and the payment of the dividend mentioned.

Mr. D. H. Goodsall, in seconding the motion, stated that at the last Telegraph Conference at Buda Pesth it was resolved that what was called the effective franc should be instituted. In countries where gold was at a premium, or the currency was at a discount, as in Brazil, they had to take payment for messages in the currency. When they converted this currency into gold to remit to England, they found last year that they had to give three milreis of paper for one milreis of gold. The Conference decided that this was unjust to the companies, and agreed to a clause, which would come into force on July 1st next, to the effect that in future the franc should be collected in gold, so that if the currency were at a discount, telegraph companies should be authorised to collect enough currency to give them the gold they wanted to remit to London.

The motion was carried unanimously.

West India and Panama Telegraph Company, Limited.

The fortieth ordinary general meeting was held on Wednesday at Winchester House, Mr. C. W. Earle presiding.

The Chairman remarked that, notwithstanding the increase in the traffic returns, he could not congratulate them. They were all aware of the depression of trade and commerce from which the West Indies were suffering, and so alarming had the condition of things become, that in the beginning of the year a Royal Commission was sent out to inquire into the cause of the great depression, and to see if anything could be done to remedy it. The Commission had returned, and the issue of its report was looked forward to with great anxiety. With the failure of prosperity in the West Indies, the company's position could not be very brilliant. The expenses of repairing the cables during the last half-year had been £9,015, or £1,918 in excess of those for the corresponding period of 1895. The increase was owing to the fact that the company's vessel, the *Grappler*, was engaged on cable work in very deep water for 147 days, as compared with 96 days in the previous period. They had some anxiety in connection with the fate of the Croix cable, which was laid in 1875. It had, therefore been 22 years in the water, and the action of the sea on the wires had so weakened the cable that they could not lift it to make permanent repairs. The ship had been working 40 miles in the direction of Trinidad, and was now awaiting fine weather to start on the work again. He could not say what the result would be until the cable had been investigated further south. He then referred to the great competition with which they had to contend, as set out in the directors' report, and stated that in order to meet it they had had to reduce their rates. The French Company's cable between St. Domingo and Martinique was interrupted, and therefore they had not yet felt the whole force of the competition. The amount to the credit of revenue was £34,053, against £33,558 for the corresponding period of 1895, and the expenses had been £21,398, against £19,676, leaving a balance of £12,654, which was increased by the amount brought forward to £14,622. After providing for the dividends on the first and second preference shares they recommended a dividend of 6d. per share, tax free, on the ordinary shares, leaving a balance of £646 to be carried forward. He concluded by moving the adoption of the report, which was seconded and agreed to.

Reuter's Telegram Company, Limited.

The report for the year ended December 31st last, to be presented at the general meeting to be held in London on 26th inst., states that the net profits for the year, after payment of current charges, and deducting rebate on unexpired subscriptions, amount to £9,708, including £177 brought forward. The directors have decided, as on the last occasion, to appropriate a considerable portion of the profits to strengthen the reserve. They, accordingly, have carried the sum of £4,686 to that fund, making it £20,000. An interim dividend of 2½ per cent. was paid in October last, and the directors now declare a dividend of 4s. per share, equal to 2½ per cent., making a total distribution, free of income-tax, of 5 per cent. for the year. This will absorb £4,859, and, after adding £4,686 to reserve, there will remain a balance of £163 to be carried forward.

Brunner, Mond & Co., Limited.

The report for the nine months ended March 31st states that the accounts show a balance to the credit of profit and loss account on the working of the nine months of £232,911, which, with £95,944 brought forward, makes a total of £328,854. The interim half-yearly dividend on the 7 per cent. preference capital, paid on February 27th, absorbed £19,394, and the preference dividend now proposed absorbs £10,289. The interim half-yearly dividend on the ordinary capital at 20s. per fully-paid share, and 7s. per partly-paid share, paid on February 27th, required £95,084; and the dividend to be now paid on the ordinary capital at 25s. per fully-paid share, and 8s. 9d. per partly-paid share, making 30 per cent. per annum for the nine months, takes £118,855. The amount to be written off patents account is £500, the balance to be carried forward being £84,732.

Easton, Anderson & Goolden, Limited.—An issue of £150,000 of 4½ per cent. debenture stock has been advertised for public subscription this week. The company has a nominal capital of £200,000, in 10,000 6 per cent. preference and 10,000 ordinary shares of £10 each. The issue is stated to be made for the purpose of consolidating at a lower rate of interest previous debenture issues, and also for providing additional working capital for the full development of the company's business. The present fair value of the works, together with the fixed plant and machinery, loose tools and utensils, stock, &c., as a going concern, is estimated by Messrs. Fuller, Horsey, Sons & Cassell, at £230,356. The directors of the company are Messrs. T. Perceval Wilson, E. W. Anderson, L. B. Atkinson, H. K. Baynes, J. E. Compton-Bracebridge, F. S. Courteney, and W. T. Goolden. The secretary is Mr. W. E. Davies, and the offices are at Broad Sanctuary Chambers, S.W., and the works at Erith Ironworks, Erith, Kent.

Stock Exchange Settlements.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in, and to grant a quotation to, Callender's Cable and Construction Company, Limited—20,000 shares. Edmundson's Electricity Corporation, Limited—17,400 ordinary shares. And to allow the following securities to be quoted in the Official List:—British Aluminium Company, Limited—20,000 7 per cent. cumulative preference shares, Nos. 1 to 20,000, and 10,000 ordinary shares, Nos. 1 to 10,000. Edison and Swan United Electric Light Company, Limited—Further issue of 10,000 "A" shares, Nos. 89,262 to 99,261.

Consolidated Telephone Construction Company, Limited.—The directors have resolved to declare a dividend, subject to audit, of 2 per cent. for the year ending March 31st last.

Willans & Robinson, Limited.—The registers of debenture stockholders and of transfers will be closed, prior to the payment of interest, to 30th inst., inclusive.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending May 16th, 1897, were £1,000; week ending May 17th, 1896, £864; increase, £136; total receipts for half-year, 1897, £20,503; corresponding period, 1896, £18,800; increase, £1,703.

The Liverpool Overhead Railway Company. The receipts for the week ending May 16th, 1897, amounted to £1,352; corresponding week last year, £1,125; increase, £227.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending May 14th, 1897, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,084.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, May 12th.	Closing Quotation, May 19th.	Business done during week ended May 19th, 1897. Highest.	Lowest
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	...	100 —104	100 —104	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	4⅛— 5⅛	4 — 5	4½	4⅜
1,612,880£	Anglo-American Teleg., Ltd.	Stock	£2 2s.	£2 9s.	£2 13s.	49 — 52	49 — 52	...	...
2,993,560£	Do. do. 6 % Pref.	Stock	£4 4s.	£4 18s.	£5 6s.	93½— 94½	93½— 94½	94⅞	94
2,993,560£	Do. do. Defd.	Stock	...	...	...	7⅞— 8¼	7⅞— 8¼	8	...
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	...	14⅜— 15½	14⅜— 15½	15 3/16	15
75,600£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	113 —117	113 —117	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	2½%	4 %	...	3¼— 3⅜	3¼— 3⅜	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	173 —177	173 —177	176½	175½
40,000£	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	99½—100½	100 —101	100⅝	99⅞
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	1½%	2 %	1/16— 1/16	1/16— 1/16	...	..
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	10 — 11	9½ — 10½	10½	9⅝
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	19 — 20	19 — 20	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	3½— 4½	3½— 4½	...	...
5,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 10½	10 — 10½	...	...
80,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	4½%	105 —108 %	105 —108%	108	...
60,710	Direct United States Cable, Ltd.	20	2 %	2½%	2½%	8½— 9	8½— 9	8⅞	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	16⅞— 17½	16⅞— 17½	17⅛	17
70,000	Do. 6 % Cum. Pref.	10	6 %	6	...	18 — 19	18 — 19	18½	18½
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	103 —106	103 —106	...	...
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	127 —130	127 —130	129	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	%	18 — 18½	17⅞— 18¼	18 3/16	17 13/16
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5%	100 - 104	100 —104	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5%	101 —104	101 —104	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4%	128 —131	128 —131	...	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5%	100 —104	100 —104	...	...
107,600£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5%	101 —104	101 —104	...	...
800,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4%	107 —110	107 —110	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4%	107 —110 %	107 —110%	107	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	...	11 — 11½	11 — 11½	11⅜	11 3/16
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	17 — 17½	17 — 17½	17½	...
150,000	Great Northern Teleg. Company of Copenhagen	10	8½%	10 %	10%	24½— 25½	24½ - 25½	25⅛	...
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5%	102 —105	102 —105	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10%	55 — 58	53 — 56	...	...
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6%	107 —110	107 —110	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 %	5⅛%	5⅛%	6⅜ - 6⅝	6⅜ - 6⅝	6⅝	6½
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	15⅞	15½
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6 — 6½	6 — 6½	6 7/16	6 5/16
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	105 —109	105 —109	107	105½
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	4½%	5 %	5 %	⅝ - ¾	⅝ - ¾	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	107 - 110	107 —110	...	...
11,839	Reuter's Ltd.	8	*nil*	5 %	5 %	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert	...	...	...	135 —140	135 —140	...	...
58,980	United River Plate Teleph., Ltd.	5	3 %	4 %	...	3½ - 3¾	3½ - 3¾	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	...	100 —105	100 —105	...	...
15,509	West African Teleg., Ltd., 7,501 to 23,109	10	*nil*	4 %	...	5 — 6	5 — 6	...	...
238,260£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	101 —104	101 - 104	...	...
30,000	West Coast of America Teleg., Ltd.	10	*nil*	*nil*	...	⅜ — 1½	⅜ — 1½	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	103 - 108	103 - 108	...	...
64,248	Western and Brazilian Teleg., Ltd.	15	3 %	3 %	2 %	7½ - 8	7½ — 8	7 13/16	7½
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6½ - 6⅝	6½ - 6⅝	...	...
33,129	Do. do. do. Def. Ord.	7½	1 %	1 %	...	1½ - 1⅝	1½ - 2	1⅝	...
165,280£	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	6 %	... ...	... ...	...	...
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	6 %	... ...	... ...	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅛%	⅛%	1 %	⅛ - 1⅛	⅛— 1⅛	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11 — 11½	11 — 11½	11⅜	11½
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	9½— 10½	9½— 10½	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,600 ...	100	5 %	5 %	5 %	107 —110	107 —110	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7%	104 - 108	104 —108	...	...
164,300£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6%	100 05	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

50,000	Charing Cross and Strand Electy. Supply ..	5	4½%	5 %	6 %	10½— 1⅛	11⅛ - 12⅛	12⅜	11⅛
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 1 1/16	6 — 6½	..	...
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	5 %	8⅜— 9½	8⅜ - 9½	8 15/16	8 13/16
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	4½%	4½%	112 —115	112 —115	...	..
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	5 %	7 %	22 — 23	23 — 24	23⅜	22½
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16½— 17½	17 — 18	17⅝	17 5/16
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	130 —135	131 —136	134½	132½
22,475	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—22,475	10	...	*nil*	*nil*	12¼— 12⅜	12¼— 12⅜	12⅜	12 5/16
20,000	Do. do. do. 6% Pref., 40,001—50,000 ...	10	...	6 %	6 %	14⅜— 15½	14⅜— 15½	15½	15
10,000	Do. do. do. iss. at 2 pm., all paid	10	...	...	.	14½— 15	14⅜ -- 15½	15	14⅜
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5	...	...	...	7¼— 7⅜	8¼— 8⅜	8½	7⅜
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	3 %	4 %	5 %	16½— 17½	17 — 18	17 7/16	17⅛
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem. ...	10	...	...	...	13 — 14	13½— 14½	14	13⅜
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	120 —124	120 —124	119½	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	1 %	2 %	4 %	13 — 14	14 — 15	13 5/16	13½
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	6½%	7½%	10½%	15 — 16	15½ — 16½	15⅝	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10 — 11	10 — 11	10½	...
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	...	104 —107	104 —107	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 68,000 ..	5	5 %	7 %	9 %	13½— 14½	15 — 16	15⅛	14⅜

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.
§ Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation May 12th.	Closing Quotation, May 19th.	Business done during week ended May 19th, 1897. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	5	2½%	...	...	⅞ — 1⅛	1⅛ — 1⅜	1¼	1 1/16
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	...	...	1⅜ — 1⅝	1½ — 1¾	1⅝	1 9/16
125,000	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	...	...	104 —108	104 —108	...	...
76,770	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	95 — 99	95 — 99	...	...
19,126	Central London Railway, Ord. Shares	10	...	...	...	9⅜ — 10¼	9⅜ — 10¼	10	9 15/16
143,103	Do. do. do. £6 paid	10	...	...	...	5⅝ — 6	5½ — 6	5⅝	...
51,951	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1½ — 1⅝	1½ — 1⅝	1 9/16	1½
54,501	Do. do. Def. do. £5 pd. ...	...	...	...	...	4⅜ — 5½	4⅜ — 4⅝	4½	4 17/16
630,000	City and South London Railway	Stock	1½%	1 3/16%	1 9/16%	58 — 60	58 — 60	59½	58¾
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	*nil*	...	1⅜ — 2¼	1⅜ — 2¼	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	5 %	5 %	...	1⅜ — 2¼	1⅜ — 2¼	1⅜	...
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5 %	...	3 — 4	3 — 4	3¼	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	4½%	4½%	...	105 —110	105 —110	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	5 %	...	1½ — 1⅝	1⅝ — 1⅞	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	2⅜ — 3¼	2⅜ — 3¼	3⅛	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	...	...	¾ — 1	¾ — 1	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	...	...	¼ — ½	¼ — ½	...	...
9,600	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	10½%	...	11 — 13	11 — 13	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	6 %	8 %	10 %	18½ — 19½	18 — 19	18¾	18⅛
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½ — 19½	18½ — 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	4½%	4½%	108 —113	108 —113	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	20½ — 21½	20½ — 21½	21⅜	21
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	104 —107	104 —107	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	2⅞%	2⅞%	12 13/16 — 12 15/16	12⅞ — 12⅞	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15½ — 16	15½ — 16	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	15 %	34 — 37	34 — 37	37½	35½
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	103 —106	103 —106	...	...
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £8 paid ...	10	...	...	...	10¾ — 11¼	10¾ — 11¼	11 3/16	10⅞

Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%; 1890—8%

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 9⅛.

Electric Construction Corporation, 6 % Debentures, 104 -107.

House-to-House Company, 7 % Preference, of £5, 9½—10.

Do. do. 4½% Debentures of £100, 109—111.

* From Birmingham Share List.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 11¾—12¼; 1st Preference Cumulative 6 %, £5 (fully paid), 8—8½. Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 1½—1⅝.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8½—9. Dividend for 1896—6 %.

Bank rate of discount, 2 per cent. (May 13th, 1897).

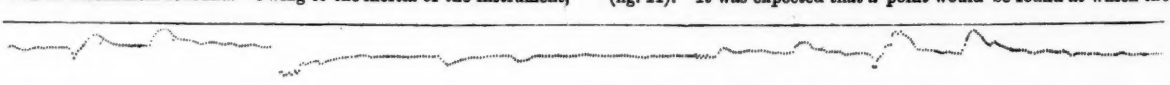
PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

DISTURBANCE OF SUBMARINE CABLE WORKING BY ELECTRIC TRAMWAYS. By A. P. TROTTER, Member. (Read May 13th, 1897.)

(*Concluded from page* 670.)

On September 3rd, as a supplement to Mr. Rommel's experiment, the siphon recorder was, at my request, connected direct to the core and sheath of the cable, without condensers. The cable was through to Mossamedes. The character of the disturbances was somewhat altered; the return was, as might be expected, less prompt, and there was no mechanical rebound. Owing to the inertia of the instrument, the maximum deflection was reached in about 0·3 of a second, and the deflection of 3 mm. died away in about 0·7 second, and returned to the zero line (fig. 9). The zero line without condensers was by no means straight, but it was sufficiently so to indicate that the disturbances were in all probability due to induction, and not to direct

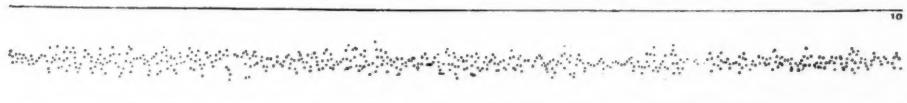


No condenser. Through to Loanda, September 3rd.

FIG. 9.

disturbances would be reduced to zero, and that beyond this they would be reversed, but neither reduction nor reversal could be obtained.

On September 15th I made a report to the Postmaster-General upon the results of the experiments, and summarised the five courses



Durban Road earth, August 17th, 1896.

FIG. 10.

leakage. If time had permitted, experiments without condensers would probably have thrown some light upon the real nature of the disturbances.

On September 5th a telephone line to Salt River, a distance of 2¼ miles, and at an average distance of 200 yards from the railway (nowhere less than 100 yards) and about 350 yards from the tramway, was used for an earth. Besides the usual tramway kicks, a continual vibration due to the railway and post office telegraph lines (especially the quadruplex), which run along the railway, was recorded on the tape, but not nearly so remarkable as in the case of the Durban Road earth already alluded to (fig. 10). I regret that this experiment was not repeated with the condensers removed, in order that the effect of earth currents might be distinguished from induction.

Another attempt was made on September 15th to neutralise the disturbances by means of an equal and opposite induction. Mr. Shaw, of the staff of the *Great Northern* cable ship, was present. The telephone line to Mowbray and the sheath of the cable and the siphon recorder were connected up through a rheostat so that resistance taken out of one earth could be added to the other (fig. 11). It was expected that a point would be found at which the

which might be adopted. 1. Make a remote earth connection by means of a telegraph line. (This has been so far unsuccessful). 2. Neutralise. (This has also been unsuccessful.) 3. Prevent all leakage. (This is impracticable.) 4. Reduce abruptness of change of current. Recommended if Nos. 1 and 2 fail. 5. A last resort, but a sure one: lay a few miles of new two-core cable across the bay.

Mr. N. Shaw continued to make experiments, at which I was not present. I understand they were not successful. On October 1st the tramway was opened to Sea Point (see map), and the increased traffic resulted in a marked increase in the number and in the amplitude of the disturbances. The operators had begun to read the signals in spite of the kicks, but after this date the signals were almost always

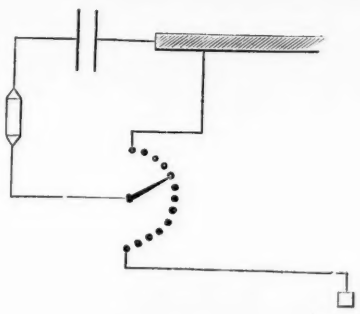
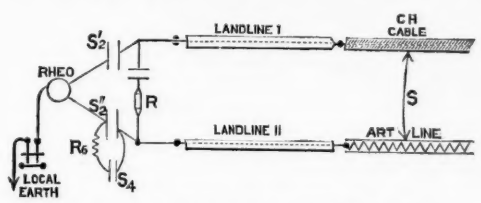


Fig. 11.

illegible while the trams were running. In order to try a still more remote earth, a military telegraph line was run, under the superintendence of Captain O'Meara, along the shore of the bay to the point marked A on fig. 1, and was terminated there with a copper plate in the sea. The result is shown in fig. 12. On October 3rd the disturbances appeared to be reduced, but on October 5th—a public holiday in Cape Town—they were as bad as ever. It has been noticed that the amplitude of the kicks is much greater on some days than on others; but this variation has not been traced to the changes of weather, and may be due to nothing more than heavy traffic. Other



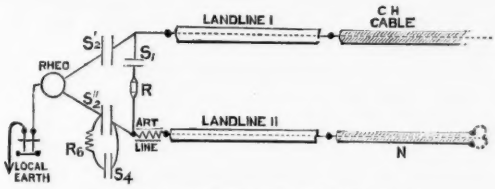
s, Sheathing of cable to earth plate of artificial line.

Fig. 13A.

experiments were made with a differential choking coil by the cable company's staff, and earths at the point A, and at Durban Road (12 miles from Cape Town along the railway), were tried, both separately and in shunt to the sheath, but without any promise of success. A sample of the slip taken at one of these experiments is shown in fig. 13.

working, as it was only a makeshift and very inconvenient. The cable was not actually under duplex conditions—that is, the company could not work duplex—the artificial line being only used as an adjustment to counterbalance the disturbance on the cable.

The only remaining method was to lay a length of new cable. Three ways of employing such a cable present themselves. First, the old cable might be picked up and landed at a hut on the other side of the bay, and two cables or a two-core cable laid from that hut to Cape Town. Second, a two-core cable might be jointed to the old cable at some 5 or 6 knots distant from Cape Town, one core being spliced to the core of the old cable, and the other being connected to the sheath. The third way is simply to lay a cable over the old one, terminating in an earth plate or joining the core to the sheath.



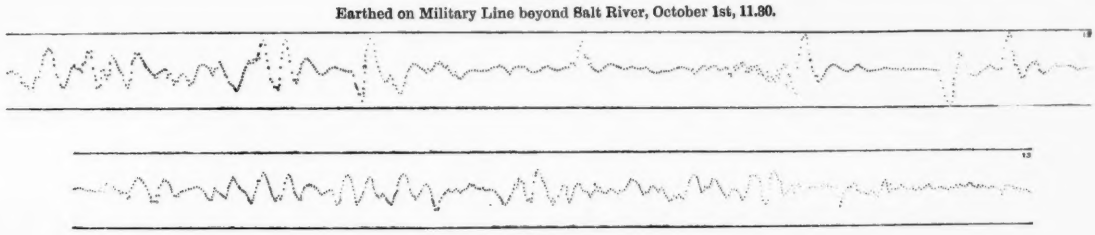
N, New earth line 5 miles out to sea.

Fig. 14A.

No steps could be taken until the *Great Northern* arrived at Cape Town. The cable was laid under the superintendence of Mr. Harold W. Ansell on January 20th, 1897. The end had been sealed. The sheath and core were connected to the instrument at the cable hut, and I am informed that kicks in all respects similar to those of the old cable were recorded. An attempt was made to neutralise or reverse the disturbances in the old cable by means of those in the new one, but without success. On January 22nd an earth plate was attached to the end of the new cable, and to the great satisfaction of those who were present, a nearly continuous line was drawn by the siphon (fig. 14). A few kicks of an amplitude of rather less than 1 millimetre were visible. Later in the day the earth plate was removed, and the core was soldered to the sheath, and the end was sealed to keep the sea water from the soldered joint. This arrangement is shown in fig. 14A. The length of the new cable is about 5 knots, and it was laid as nearly as possible over the old one. Since that date the traffic has been resumed, and no appreciable disturbances have been noticed.

Fig. 12.

Earthed on Military Line beyond Salt River, October 1st, 11.30.

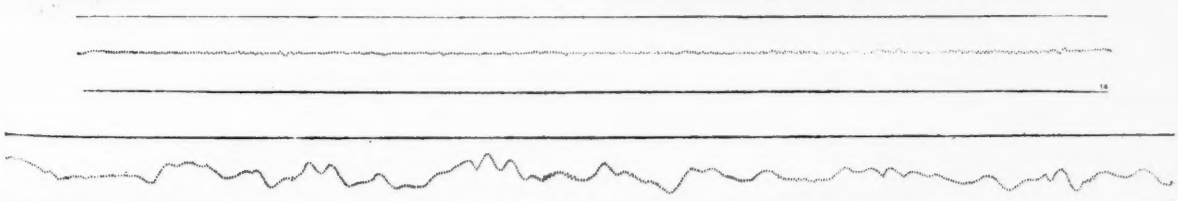


Earthed at Salt River, October 6th.

Fig. 13.

At the first series of experiments Mr. T. Cassidy, Mr. H. Spetch, and one or more of the Cape Town staff of the cable company were present, together with Mr. W. B. Rommel, engineer of the Cape Town tramway companies; Mr. E. G. Jones, late electrical engineer of the Cape Town Corporation, and now resident engineer of the tramway companies; Mr. B. Bayly, Metropolitan District engineer and surveyor of the Post Office, and myself. On the last occasion Mr. A. Worswick, engineer of the Port Elizabeth tramway, was present, Mr. Rommel being away.

In the course of these experiments enough theories have been propounded, and cures proposed, to fill a volume. To non-cable electricians it is not easy to see why such disturbances should not be



Figs. 14 and 15.

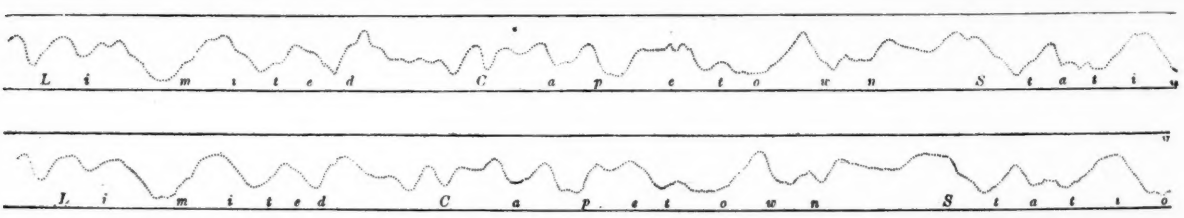
Early in October the cable was duplexed at the station; but no appreciable difference was noticed until, as I am informed, at the suggestion of Mr. H. A. C. Saunders, on December 24th, it was put on duplex connections with the artificial line at the cable house, as shown in fig. 13A, from which date until January 14th the whole of the traffic was carried in a satisfactory manner during the interruption of the alternative route on the East Coast. On the restoration of the East Coast route the company discontinued this plan of cancelled by means of an equal and opposite induction. There appears to be no difficulty in getting an opposite one, and it would seem that by shunts and resistances it could be made equal. The difficulty seems to have been that, while it was possible to produce differences of potential, there was no point within several miles as a *point d'appui* where the potential was fixed. The distributed character of the induction is such that no useful effect could be produced by a small current shunted from the main current leaving the station.

The sensitiveness of the siphon recorder to neighbouring telegraph currents introduced further difficulties when a good earth was sought. Many other very interesting investigations might have been made had time permitted, such as the distribution of the current which caused the induction, especially out at sea.

Surprise has been expressed in Cape Town that the tramway companies should "allow so much current to run to waste into the sea that some of it gets into the submarine cable." A sufficient answer to this is that the current causing the disturbance is about a twenty-millionth part of the average current generated at the works. But, seriously, the magnitude of the primary current which induces the secondary current in the cable is very difficult to estimate. The 2 or 3 amperes that pass through the earth plates when about 200 amperes are being generated probably play only a small part.

Although at the present date, owing to the increased traffic, the fall of volts on the rails from Sea Point to the works is rather serious, at the time of the first experiments when only five or six cars were running it was well under 1 volt; and nothing more could be asked from a tramway company using their rails as a return. At one time I thought that, if the starting current could be switched on "by some efficient method of gradually varying resistance," say in five steps of 4 amperes, succeeding each other at intervals of not less than one-fifth of a second, the five little kicks would be too small to interfere with the signals, and each would have time to die away before the next began. A worm-wheel on the controller would prevent the driver switching on too fast. But in mounting a hill a well-loaded car may take from 80 to 100 amperes, and to break this in 4-ampere steps at intervals of a fifth of a second would occupy from two to two and a quarter seconds. Since it is necessary that the reversing switch of a controller should be locked until all the current is cut off, such an arrangement would materially delay an emergency stop. If the current to be broken were always the same, it could be switched off from the motor to a resistance and then gradually reduced by the controller. But the varying current renders this impracticable. It is not worth while to discuss other details of methods of preventing the disturbances, since it would be always more satisfactory, and generally cheaper for a tramway company, to lay a short length of cable, as has been done at Cape Town.

The causes of the disturbances which have been experienced in this case are very different from those which affect telephones. The attention of the Joint Committee of the House of Lords and of the House of Commons which was appointed in 1893 to consider and report whether the grant of statutory powers to use electricity ought to be qualified by any prohibition or restriction as to earth return currents, or by any provisions as to leakage, induction, or similar matters, was confined to telephone and railway signal interferences. It is hardly necessary to remark that the rapidly fluctuating character of the current produced by the commutator of the motor, which is the chief cause of the trouble with telephones, would have no effect on a siphon recorder; nor would a strong continuous current, such as those which often get astray in Cape Town, dropping the indicators at the telephone exchange a dozen or two at a time, affect an instrument protected by a condenser. The sparking of the trolley at insulators is sometimes audible in a telephone, and the roar, as distinguished from the hum, is probably due to a dirty track. These are matters of small moment as far as a submarine cable is concerned. I have carefully listened for a click or other sudden sound in a telephone at the moment a hum begins or ends. The click, if any, at the beginning is very insignificant, and I have never heard any click whatever when the hum stops.



Figs. 16 and 17.

Figs. 15, 16, and 17 are specimens of slip. Fig. 15 was recorded before the new cable was laid; the signals are unreadable owing to the tramway disturbances. Fig. 16 gives the words "Limited Cape Town Station," the recorder being earthed to the sheath of the old cable. The disturbances happen to be very slight. Fig. 17 gives the same words with the recorder earthed on the new cable.

In conclusion, I have to thank the Eastern and South African Telegraph Company for inviting me to take part in the experiments. I hope that this paper will be supplemented by an account of the experiments at which I was not present.

Northern Society of Electrical Engineers.

The Transmission of Power in Factories by Electricity.

Read Monday, May 17th, 1897, by S. V. Clibehugh, Member.

My intention to-night is to put before you some points in connection with power distribution by means of electricity, more particularly in factories, and especially in those factories devoted to the textile trades.

I wish at once to state that I am not of opinion that electricity is the remedy for every extravagant coal bill, but I know it is a remedy for many. A few years ago there were people, even electrical engineers, who went about proclaiming that the days of shafting and rope driving were at an end, and that every new cotton mill would drive each line shaft, and even each machine, as some enthusiasts alleged, by means of electric motors. This was not only unreasonable, but it was harmful to the industry. Mechanical engineers, who for years had had experience of equipping cotton mills, and who knew to a fraction what power each machine took, resented the fact that a body of men, who knew nothing at all about the intricacies of driving such machinery, should come in and teach them their business. They therefore looked closely into the claims of electricity, and found that the loss was so small, that even if 50 per cent. of the losses could be saved by electricity, the additional capital outlay would more than outbalance the annual saving. Fifty per cent. sounds a lot, but when the losses in driving a cotton mill are not probably more than 20 per cent. of the B.H.P. developed, and you are dealing with engines which will develop an I.H.P. hour for 2 lbs. of coal, 50 per cent. is not sufficient saving; in fact, there is not a big enough margin of loss to cut at.

It should be remembered that even in Switzerland, where there are towns in which all the mills are driven by electricity from a central supply, they do not distribute the power inside the mill by means of electricity, but the millowner buys an electric motor in the same way as the millowner here buys a main steam engine, and they both, as far as I am aware, distribute by means of ropes and shafting.

Fortunately, however, for the electrical industry, we have, especially in Lancashire, industries on which the margin of loss in the distribution of power is so enormous as to enable us to effect a large money saving if we only reduce them by 20 per cent. The dyeing, bleaching, finishing, and printing trades, in my opinion, use more coal per B.H.P. hour than any other trades in the world. The reasons for these are not far to seek.

Partly owing to tradition, and partly owing to necessity, partly, also, to convenience, nearly every machine in these trades has its own prime mover. One cannot, for instance, imagine a printing machine being driven off shafting, even were it provided with the most complicated system of speed cones, &c. The same applies to a callender, or mangle, and half a dozen other machines one could mention. In addition, even in machines where it might be possible, the attendant is so accustomed to have the stop valve of the engine ready to his hand that he could hardly work the machine without it or its equivalent. Here, then, is material ready for the electrical engineer. Even the worst-designed job will generally make the customer grateful, because you cannot by any stretch of the imagination waste more power, and the probabilities are you will save something.

The difficulty is to induce the proprietor to spend the money. An electrical installation is not a cheap thing, as I shall presently show, and it is of little use to tell a man that by an expenditure of £5,000 he will save £1,250 per annum, or 25 per cent. on the outlay, if he has not £5,000 to spare. The general answer you will get is, "Trade is bad and the profits are too small. I can't afford it."

A curious commentary on the methods employed by other nations is afforded by Germany. It is just when trade is bad and profits small that in that country there is an opportunity of introducing improvements.

It is extraordinary how suspicious people are if you mention that you can effect any big saving, and how difficult it is to get them to go into the matter and to try and find out how you propose to do it. I suppose they have been so often bitten by the travellers who sell them oil which saves half their coal bill, the man with patent firebars, &c., that they have lost all faith in their fellow men.

I have, however, recently been connected with some power installations of considerable size, and, while not wishing to weary you with a detailed description of each machine, I feel that some of the principal points in which difficulties presented themselves and the method of getting out of them may be of interest.

The first question that occurs is, what is the best form of generating plant for the purpose? Let us assume that 200 H.P. will be required and that steam will be used.

I am of opinion that a direct-coupled plant of moderate speed is the best, having regard to running expenses, depreciation, and capital outlay, the difference in cost between a rope-driven plant, in which the engine runs at 100 revolutions and the dynamo at 500, and a direct-coupled plant running at 200 revolutions being practically negligible, the dynamo, of course, being a multipolar one. Special circumstances might lead one to a lower speed, say 120 revolutions, in order to be able to use a trip gear, but in this particular size it would, I think, be wasteful in capital outlay.

The type of engine I have found most satisfactory is an inverted vertical compound (if the boiler pressure is anything over 90 lbs.), with piston valve on the high pressure cylinder and balanced slide on the low pressure, the governing being done by means of an automatic shaft governor. The engine should be of the enclosed type, and the lubrication should be under pressure. As a rule, with an engine of

this speed, an ejector condenser is the most convenient and will give a good vacuum, there being no moving parts.

The dynamo direct connected through a flexible coupling would probably be of the six-pole type, the armature, of course, being slot wound. It is absolutely essential that there should be very little movement of the neutral points with varying loads, and I have machines running now which only require an alteration of the brushes once between no load and 20 per cent. overload. There is absolutely no sparking. The E.M.F. I have generally adopted is 200 volts. Of course, cases may arise in which higher pressures are advantageous. Such a combination will deliver a kilowatt hour with 30 to 32 lbs. of water, or 1 I.H.P. with a consumption of 18 to 20 lbs. of water, or about 2½ lbs. of coal.

I do not, of course, point this out as being anything special in the way of economy, but with the varying loads it is probably as economical as can be obtained, having regard to the capital expenditure and wear and tear. I have had such a combination as this running 24 hours for six days on end, only stopping on Saturday night.

The first point on which difficulties arise is the question of the speeds and powers of the motors, and the best method of gearing them to the machines. It is with regard to the power taken by the various machines that the greatest difficulty arises. In order to economically carry out work of this character, it is essential that the motors should fit their work, for by the amount by which you have unnecessarily increased your capital outlay, by the interest on that amount have you reduced your saving.

Although most of the machines you are asked to drive have not differed very much in form for the last 20 years, if you go to the maker and ask what power a machine takes to drive it, he says, "We generally use a pair of sixes." Now this to a man striving after exact information is disheartening. I tried, indicating some of these engines, and have some hundreds of diagrams, but they give you little information owing to the leaky state of the glands, and the fact that, as the steam is generally so wet, they nearly always run with the drain cocks open. The diagrams show no signs of cut-off except at the extreme end of the stroke.

Another difficulty we have is, that what we want to know is not the maximum power taken by the machine in starting, but the maximum normal power required. A steam engine has to be put down of sufficient size to develop the maximum power required; a motor, only the maximum normal power required.

In connection with this matter, I should like to mention that beautiful little device, Royce's time fuse, which, for motor work, is unsurpassed. Until recently one always put a mercury cut-out in circuit with a motor, which, *directly* the motor load exceeded a given amount, opened. Of course, in time it had a lump of something heavy tied to it, which prevented it working at all. Now, by means of a time fuse, you can have a given overload on a motor for a given time, which is exactly what we want, so that a motor may exert 50 per cent. more than its rated load for, say, three minutes, without blowing the fuse or doing itself any harm; for we know that, with any motor worth its salt, it will give out any amount of power till it is stopped by the heating of the armature conductors. In one installation I have fixed these cut-outs on a switchboard, and put an electric bell and indicator in circuit, so that when a time fuse goes it rings a bell and indicates the number of the circuit. Thus the foreman of the room is enabled to find out, if a certain machine blows its fuse several times, that there is something wrong either with machine or operator.

I have tried many ways to arrive at the exact power required for various machines, but the most satisfactory course, where it is practical, is to drive the machine electrically. It is very often possible to take a motor round, and get a very good idea by driving with a belt. There is, however, no golden rule to be followed, but I would warn my hearers that when they test a machine they should be sure they test it under all the varying conditions under which it will ever work. It is surprising to find the difference in the power required by a machine if it is passing slightly heavier cloth than usual.

Take a callender for instance. The power it will take within several horse-power depends largely upon the mood of the attendant who sets it. He will climb up and insert a "tommy" in the screw, and twist until he thinks he has the requisite amount of pressure. Now, a quarter of a turn may make a difference of 20 per cent. in the power taken. Again, the conditions of the bearings makes a surprising difference. It was reported to me recently that the time fuse on a callender was always blowing. This callender took, under normal conditions, 80 amperes at 200 volts, or 22 E.H.P., and the time fuse was set to blow at 100 amperes after five minutes. I investigated the matter, and found it was quite a common occurrence for one of the callender bearings to get hot, not sufficiently hot to necessitate stopping, but this brought the power required up to 120 amperes, or 32 E.H.P.

I cannot but think that with the simple methods now available of ascertaining the horse-power taken by different machines, designs will be somewhat modified, and that machines will be constructed to do the same amount of work with half the expenditure of energy, and it must always be borne in mind that saving of the energy required does not mean only saving in coal bills, it means saving in capital expenditure, boilers, engines, motors, &c.

It may be that makers of this class of machinery have studied these questions, and have found difficulties in altering their machines; but in conversations I have had with several, they have admitted that had they designed a machine to be driven by electric motors, much complication and wasteful gearing might have been dispensed with.

There is one other point in this connection which I approach with all humility; but it has struck me that in many cases speeds of processes might be increased, and so enable a given machine to get through more work. It has seemed to me that the factor which has controlled the rate at which the machine shall work has been, in many cases, the piston speed of the engine.

Now with regard to gearing and variation of speed. The problem here is to run your motor at a peripheral speed of approximately 3,000 feet per minute, which means for an average size of motor about 1,000 revolutions per minute, and to gear it to a machine which runs at about 50 revolutions. It is obvious that we have only three methods open to us, viz.:—

1. Worm gearing.
2. Double reduction spur.
3. Single reduction spur and belt.

It is undeniable that each of these methods may be satisfactory under certain conditions; but as it is always advisable to keep the speed of the motor up to the speed I mentioned, it will be found that the peripheral speed of spur gearing is too great. I have found that when the speed of even the best cut spur wheels exceeds 1,800 feet per minute, that there is excessive wear and objectionable noise. There is sometimes an opportunity of using a belt for the drive off the motor, and then spur gearing; but as a rule either the moisture in the place, or the want of room, does not permit this.

We then come to the third alternative, *i.e.*, worm gearing. This form of gearing has been in a very bad odour for the last few years. Its efficiency was undeniably very low as it was then constructed, and although it had its uses, there was not the class of work to be done which could not be done almost equally well by spur or other forms of gearing. When, however, engineers found the necessity for combining a machine running at 1,000 revolutions, with one running at 50 revolutions per minute, then it became clear that if worm gearing could be made more efficient, it was clearly a satisfactory way out of the difficulty.

The worm gearing which I have used in many cases has given surprisingly good results, and I append here some tests made of two practically identical machines doing similar work, one driven by means of worm gearing and the other by belt.

This last will, of course, give better results than double reduction spur. The particulars of the worm gearing are as follows:—

TEST OF TWO SIMILAR MACHINES, ONE DRIVEN BY MEANS OF WORM AND WORM-WHEEL, THE OTHER BY A BELT.

Motor speed in each case, 1,200 revolutions per minute.

Rated horse-power of each motor, 11.

Speed of driven wheel on machine when worm and worm-wheel is employed, 100 revolutions per minute.

Speed of driven wheel on machine where belt-driving is employed, 240 revolutions per minute.

In each case the ultimate speed of the machine is the same, viz., 240 revolutions; but, in the case of the worm-driven machine, the spur gearing is in the ratio of 2·4 to 1; whereas, in the belt-driven machine, the ratio is 1 to 1.

The particulars of the worm and worm-wheel are as follows:—

Worm diameter on pitch circle	5 inches.
Worm number of threads	4.
Worm pitch	6 inches.
Worm-wheel diameter	22 inches.
Worm-wheel number of teeth	48.

The particulars of the belt-driving are as follows:—

Diameter of pulleys, 8 inches and 40 inches respectively.
Distance between centres, 12·0 inches.

Condition of test.	Machine No. 1.—Belt driven.					Machine No. 2.—Worm driven.					Superiority of belt over worm percentage.
	Volts.	Amperes.	E.H.P.	Time taken.	E.H.P. hours.	Volts.	Amperes.	E.H.P.	Time taken.	E.H.P. hours.	
Running empty ...	204	23	6·3	.....	...	202	20	5·4	.....	...	...
Cloth open	200	38	10·1	5 mins. 15 secs.	·88	200	42	11·2	5 mins. 30 secs.	1·02	8 per cent.
Running single cross	203	55	14·9	4 mins. 55 secs.	1·27	198	55	14·5	5 mins. 30 secs.	1·32	9 "
Running double cross	194	108	28	161 yds. per min.	·46	198	108	28·6	155 yds. per min.	·47	9 "

It is, of course, almost impossible to get two machines exactly similar. No 1 is running somewhat faster than the worm-driven machine, consequently its efficiency is somewhat higher. I think it would be found, if errors could be eliminated, the efficiency of the two forms of driving would be practically equal.

The importance of scientifically designing and fitting gearing, where efficiency is to be considered, cannot be over-estimated. The worms in all these cases were cut out of tool steel, while the worm-wheels were of phosphor bronze hobbed, thus ensuring a perfect fit. Each motor is provided with a thrust bearing, fitted with steel balls to take up the thrust.

(To be continued.)

RAPID CABLE LAYING FOR WAR PURPOSES.*

By Lieut. CRUTCHLEY, R.N.R., and C. SCOTT SNELL.

(*Continued from page 545.*)

"Each blockading fleet was superior in strength to the fleet blockaded by it, but the two hostile fleets together were stronger than either of the blockading fleets, *and* they had the advantage of being in immediate telegraphic communication across Ireland, whilst the blockading fleets could only communicate directly by means of cruisers sent from one to the other," or by other indirect method.

It is unnecessary to do more than indicate the facilities afforded by this communication for a blockading squadron to observe an enemy's port from a convenient roadstead, it might materially lessen that strain upon officers and men which on the occasion we are speaking of was nearly insupportable.

To quote again loosely only:—

Three ships escaped from Berehaven almost unobserved by the blockading squadron, and joined two other ships, which escaped from Lough Swilly, at a predetermined rendezvous. The presumption being that this would give the enemy the required superiority over the Northern squadron, the commander of the Southern fleet was obliged to raise the blockade of Bantry Bay, at the same time sending his fastest cruiser to warn the commander of the squadron blockading Lough Swilly. The following remarkable words are used:—"It was necessary in the first instance to save the two fleets from destruction in detail, and this could be done if the *Mersey* joined Rowley in time to redress the balance at Lough Swilly, and to direct Rowley to fall back in the direction of the fast and powerful squadron advancing through St. George's Channel to reinforce him."

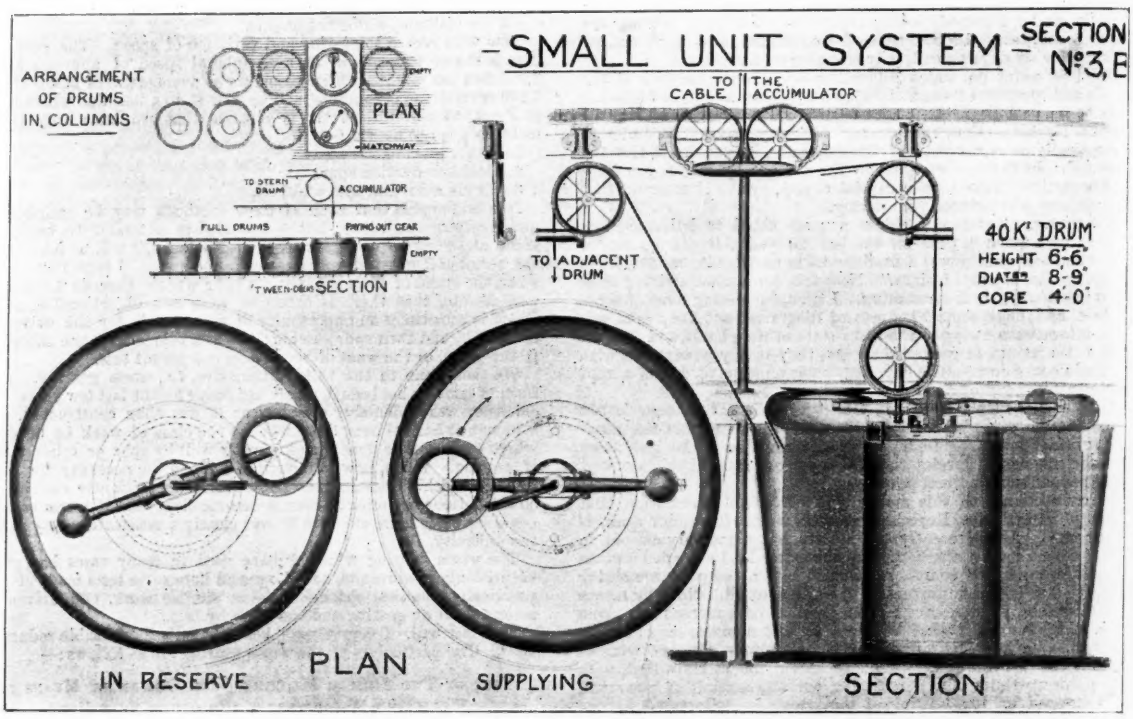
With the further second lesson drawn from the manœuvres by the writers of "The Navy and the Nation," I bring these quotations to a close:—"An organised system of coast observation and intelligence is absolutely necessary to a defending fleet, if it is to secure the full advantages of that superiority of force which is England's prerogative on the sea."

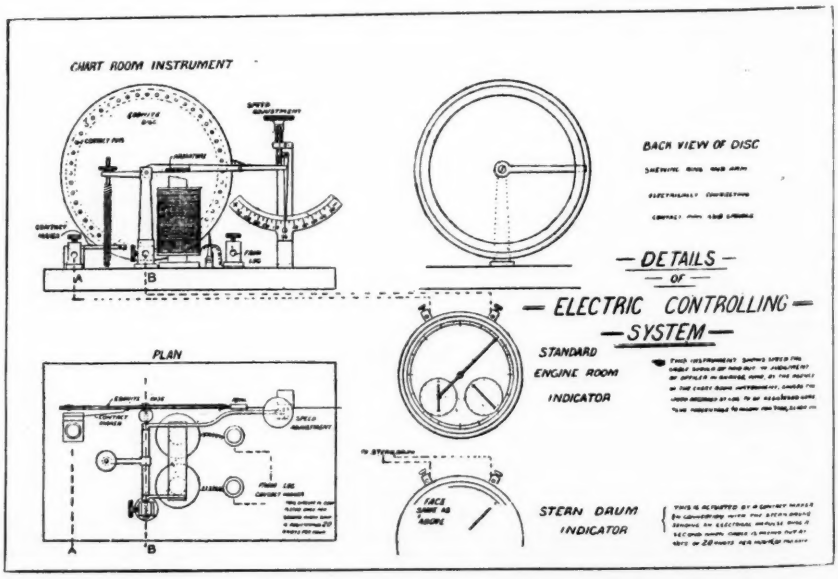
No words of mine can add weight to the opinions here expressed, which set forth absolutely the risks which may be incurred by the unexpected concentration of an enemy's force, risks which would be greatly modified, if not removed, by the adoption of Mr. Snell's invention. Furthermore, there is the great and incalculable boon of being able to lay at full speed a cable where none is shown to exist, and which consequently would not be searched for and destroyed by an enemy.

I have on a previous occasion expressed the opinion that it would be necessary in the event of naval war for the empire to possess its lines of telegraph communication in positions unknown to the enemy.

The plan which is here adopted, though not by any means perfect in detail, yet gives a workable scheme which should render this object a matter of comparatively easy accomplishment. The main object at which the inventor of this plan and myself wish to arrive at this afternoon is, as was previously stated, whether there is sufficient advantage to be got from it, to compensate for the outlay of money it would cost.

I ought, perhaps, to state that, although I have modified details of





* Read before the Royal United Service Institution on Wednesday, April 28th, 1897. The illustrations are given by permission of the Council of the Institution.

the apparatus, the invention is that of Mr. Snell, to whom I shall refer you for any explanation of mechanical details.

APPENDIX A.

Small Unit System of Carrying Cable.

This consists in placing the cable on board in drums of 40 knots capacity, and arranging them in columns. The cable is drawn alternately from each column, the wire throughout being already suitably joined up.

Two sets of special paying-out gear are arranged at the head of the columns, and as a drum gets depleted the continuation of the cable leads to the adjacent drum. The paying-out gear of the depleted drum is afterwards lifted off, and the next full drum brought into position under the gear, which is again lowered into place, and the tail wire then properly arranged on the pulleys. This operation would be required once every two hours with the vessel going 20 knots, and thus ample time exists for making the exchange of drums.

Examination of the drawings will show that an outer horizontal guide wheel, carried on a rotating arm, receives the cable as it is drawn over the rounded nosing on the drum. It is then passed to a second guide wheel in a different plane, which is mounted in such a manner as to admit of travel vertically under the tension produced on the cable, and this movement, acting upon two bell crank levers, loosens a band brake which otherwise tends to retard the rotation of the arm. This brake is put *on* by a spring.

By this system the cable is drawn off always under a certain amount of tension and a lessening demand causes the brake to be applied until the speed of rotation of the arm is suitably reduced. The overhead guide wheel is mounted to swivel automatically when the last turn of cable is run off a drum, as the cable, of course, leaves the rotating system immediately below and begins to feed from the adjacent drum.

The tail wire from one drum leads over the overhead guide wheel of the next drum, then under the vertical wheel beneath and so on, thus forming the commencement of the next drum of cable.

The counterweight on the rotating arm it is proposed to place, at first, near the centre of rotation, allowing it to run out under centrifugal force. This will admit of quicker starting from a state of rest. In the drawings this is not shown, but the modifications necessary would be very simple.

In case of a change in supply from one drum to another, impending, the brake would be applied to the "receiving drum" of the accumulator or deck, so as to momentarily lessen the speed of *drawing off*, without, of course, affecting the *paying-out* speed into the sea, the reserve of cable on the accumulator allowing of this operation.

Space does not admit of a fuller description of the system; it will be seen, however, that it has the merit of allowing very rapid loading of a vessel, and a large amount of cable may be carried. The cable would be wound on the drums with a "twist," so as to come off "straight."

Each drum may have a water tank surrounding it, readily detachable when empty drums are returned. This is necessary to enable the cable to be kept wet if the vessel is in port for a long period.

The means of making the drums fast and changing the empty ones for full ones at the heads of the columns is not shown in the drawings; indeed, to reduce the paper within reasonable limits and maintain discussion mainly upon strategic questions, necessitates much cutting down. Should opinion, however, be favourable as to the value of the power to so rapidly lay a cable, attention may afterwards be more fully focussed on the means proposed to effect it.

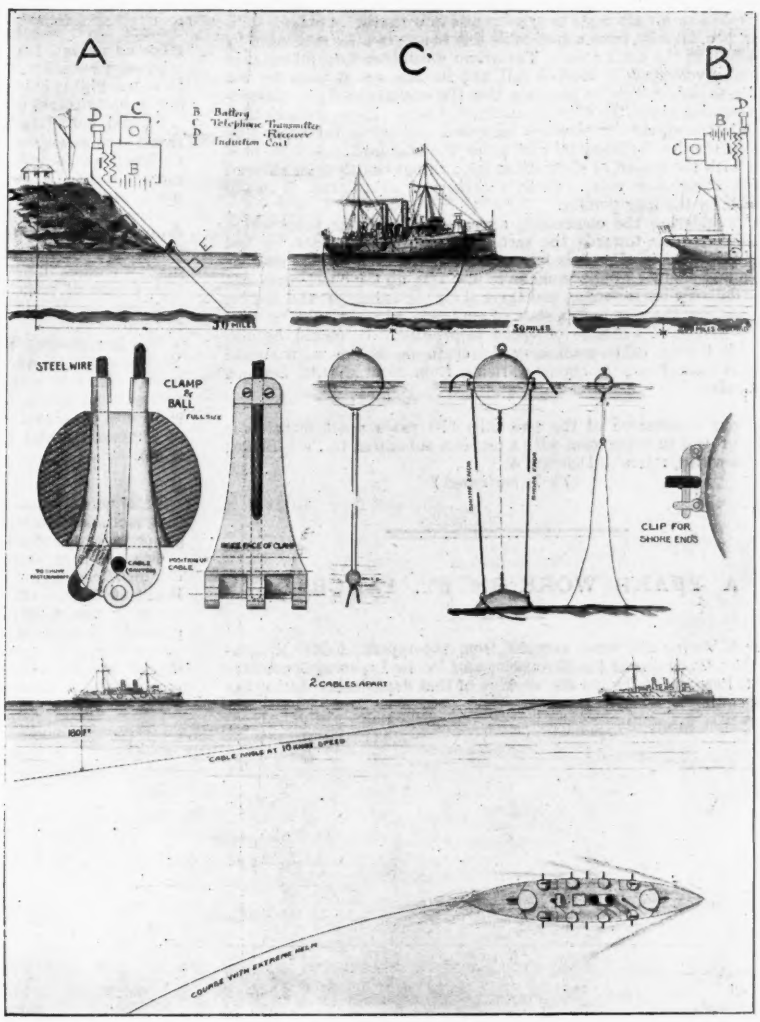
APPENDIX B.

Automatic Traveller.

The automatic traveller, which receives the cable as it leaves the drum, traverses a special alley way, constructed on the side of the tank, as will be seen with reference to the illustrations. A rack runs throughout this alley, in which a worm is caused to gear; this worm being attached to the frame carrying the pulley. On the axle of the pulley is an eccentric or crank, which oscillates by a connection rod (see A in the illustration), a pair of pawls, which in turn drive a ratchet wheel in connection with the worm, the connection being made by a pair of bevel wheels. This oscillation produces a similar oscillation in the worm, unproductive of any real traversing action, unless one of the pawls is kept out of gear by a special tripping lever (see B on the illustration); then as a result an intermittent forward traverse is given to the whole apparatus.

As to which pawl shall be thrown out of action, it is dependent upon the angularity of the cable, which will cause pressure upon one of a pair of wheels at the end or a vertical lever. This lever being connected with the aforesaid tripping lever, allows that pawl to remain in action, which tends to drive the whole appliance in the correct direction.

By the special method of swivel mounting of the pulley it can always lie in a plane tangential to the main drum, whatever the temporary diameter of the latter which, of course, varies with the quantity of cable upon it, and this is possible without in any way disorganising the rest of the mechanism. All these points will be readily understood by reference to the illustrations.



APPENDIX C.

The controlling system, whereby an officer located in a chart room keeps the attendant at the ejecting engine aware of the needed paying out speed, is worked as follows:—

The speed registered by patent log is indicated in the chart or other room, by means of any suitable device such as step by step, or pawl and ratchet, electrically actuated apparatus. It will not do, however, to transmit this same speed to the standard indicator to which the driver works, as the vessel may be running with or against a strong tide, and if passing over a rapidly deepening or shoaling bottom, further allowances are needed according to well-known rules. Within our own waters the soundings are so complete, that the ship's course being carefully kept, there should be no difficulty in making the allowance accordingly. It is in any case obvious that the driver's standard instrument will occasionally be required to read somewhat differently to the log reading, and this may be easily effected in many ways.

As an example, the instrument illustrated is a simple method. In this a vertical disc is rotated by a pawl, which is reciprocated by an electro-magnet. This latter is energised by electrical impulses controlled by the log, say, by a contact made at every 34 feet the vessel travels, that is once a second when making 20 knots speed. The disc

is provided with projecting pins in electrical connection with the spindle and supporting standard, and by the contact spring shown, as the disc rotates the circuit is completed with the standard engine room indicator.

If now the travel of the armature carrying the driving pawl be adjusted to a certain amount, each time the magnet is energised it may be made to move the disc so that a corresponding impulse will be transmitted to the engine room indicator by the contact arrangement before explained. At this point let it be assumed that cable delivery at a rate of 10 per cent. over the vessel's speed is needed; the adjustment screw is slacked back to give the armature a longer stroke, sufficient to produce in one minute, during which the electro-magnet has been energised 60 times, such a rotation to the disc that 66 contacts have passed under the contact spring, and the engine room standard is therefore showing 66 steps per minute, so that the driver must adjust his engine speed until the second indicator, which is worked by the ejecting drum astern, synchronises with the standard. By putting duplicates of these two indicators into the chart room, the driver's actions are under supervision; and if he (the driver) finds an outside pull act upon his engine, which is soon evident by its failure to respond to his attempts to synchronise it with the standard indicator, it must arise from a taut cable due to an error in reckoning by the officer in the chart room. The driver must, therefore, inform that officer by voice tube or electric bell, and he can see at once by the duplicate instruments he possesses that the engine speed is unavoidably running above the officially instructed rate. He then slacks back his adjustment screw to produce increased register in future, and by turning the disc by hand he can cause the standard index to read level with the second or stern drum one; things can then be allowed to run along once more. Great accuracy of adjustment is made possible by the long pointer.

In considering the controlling arrangement, another point which would contribute towards the successful handling must not be lost sight of. That is, all orders telegraphed by the bridge to the main or propelling engines would be made to also ring up the chart-room and cable delivery engine-room, and there show the nature of the orders, thus putting the people in a state of readiness which would be very handy in case of a change of speed impending. It should be also possible for the cable machinery driver to signal the main engine room in case of any emergency arising from trouble with his own mechanism.

In our illustration of the two coils 870 yards apart, mention is made of this in connection with a problem submitted to Prof. Blake; this, however, refers to Diagram 4.

(To be continued.)

A YEAR'S WORK IN ST. PANCRAS.

The following are some extracts from the report of Mr. E. Cox-Sinclair, Chairman of the Electricity and Public Lighting Committee of St. Pancras Vestry, on the working of that department during the year ending April last.

The total number of consumers at the end of April, 1897, was 712. The total lamps, &c., connected to the mains are:—

Lamps of 16 C.P.	25,649
Arc lamps	189
Motors representing 170 H.P.	47

During the year no less than 162 applications, representing 8,550 16 C.P. lamps, were received.

After referring to the extensions, the chairman referred to the mains as follows:—

Mains.

The following portions of work, sanctioned by the Vestry, have been executed:—

Removal and examination of bare copper mains in short sections of iron piping in Euston Road on the north side from Hampstead Road to George Street.

In every case cable has been substituted. It was found in several instances that the copper had become nearly burnt through in consequence of coming in contact with the pipes.

The copper strip mains have been increased between Cumberland Terrace, Park Street, and Britannia. Whilst this work was in progress advantage has been taken of the opportunity to replace the original porcelain bridges with specially designed insulators, in order to secure higher efficiency of insulation, so as to reduce the leakage which has hitherto been abnormally large.

Special porcelain ferrules, or insulating sleeves, have been fitted round each service wire to every consumer along the route, to prevent surface leakage and avoid rupture to the cables. In a number of cases it was found expedient to renew the services, owing to deterioration in the insulation of the lines.

Three of the manholes along this route were connected to the drains. There are others which should be similarly treated, but the inefficiency of the drainage system on the Crown property in this district renders impracticable any further attempts in this direction.

A length of main from the Britannia to Wellington Street has also been overhauled and re-insulated, and the house services carefully renovated.

The lead-covered armoured cables entering the manhole at the York and Albany were found to be in a bad condition, consequent upon not having suitable terminal ends when installed, and it was necessary to renew a portion of these mains and provide the new ends with terminals to secure permanent insulation. About 21 ends of armoured cables have been similarly dealt with in various districts.

Gas in Culverts.

From an examination of the manhole inspectors' reports, we find that each manhole out of the 320 has been dipped and examined for gas or water about 150 times during the year.

Gas has been extremely troublesome in the culverts, no less than five instances having been reported both to the gas company and the Board of Trade—all of which were of a serious nature. The gas company has endeavoured to remove all leakages as promptly as possible, although in the case of Melton Street, several months elapsed before they were successful in reducing the influx. In consequence, it was deemed advisable during the month of February, 1896, to request Major Cardew to inspect the culverts. Notwithstanding every effort, the prevalence of gas continued. Ultimately, the gas

Regent's Park Station.

	1896.			1895.		
	Units sold ... ... 1,037,020 Units generated ... 1,196,872			Units sold ... ... 849,987 Units generated ... 1,063,322		
	Amount paid.	Per unit sold.	Per unit generated.	Amount paid,	Per unit sold.	Per unit generated.
Generating—	£ s. d.	d.	d.	£ s. d.	d.	d.
Coal	3,585 9 4	0·829	0·718	3,357 10 3	0·948	0·757
Oil, water, &c.	370 16 11	0·085	0 074	363 15 7	0·102	0 082
Oil	...	0·0278	0·024	...	0 0370	0·0296
Water	...	0 0393	0 034	...	0·0478	0·0312
General stores...	...	0·0185	0·016	...	0 0177	0·0141
Wages on station	1,840 0 4	0 425	0·368	1,730 0 4	0·488	0·390
Repairs and maintenance	1,816 1 9	0·420	0·364	1,286 8 3	0·363	0·290
		1·761	1·526		1·902	1·520
Distribution—						
Wages	568 14 8	0·131	0·114	557 18 6	0 157	0·125
Repairs and maintenance	2,610 16 4	0 604	0 523	2,341 13 8	0·661	0·528
		0·735	0·637		0·818	0·654
Public lamps	521 19 2	0 120	0·104	587 1 8	0·165	0·1325
Royalties, rates, and taxes	496 12 1	0 114	0·099	405 12 9	0 114	0·0915
Management salaries	1,475 1 10	0 341	0·295	971 17 8	0 274	0·2193
Stationery and general establishment charges ..	346 14 11	0 080	0 061	315 16 10	0 089	0·0712
Law and special charges, Compensations, &c. ...	716 5 8	0·165	0 153	428 6 7	0 120	0 0366
	£14,348 13 0	0·823	0 713	£12,346 2 1	0·750	0·6111
Total cost per unit sold	...	3·320d.	...	...	3·486d.	...
„ „ generated	...	...	2·677d.	...	...	2·786d.

company unearthed an 8-inch broken main in the Euston Road, at the corner of Endsleigh Gardens. Since then the presence of gas has again been reported in that district on several occasions, but in greatly reduced volume.

On every occasion when gas has been prevalent, immediate steps have been taken to thoroughly ventilate the culverts, and the manhole lids have been kept open day and night till the influx has been satisfactorily dealt with.

In consequence of inquiries from a large prospective company who had in view the employment of electricity for motor cabs for public hire, we went thoroughly into the question of price, and in order to secure so desirable a day load, advised the vestry to supply current for this purpose at 2d. per unit. This recommendation received the approbation of the vestry on January 20th, 1897.

The resolution to supply and fix meters free of rental was confirmed, and came into force on July 1st, 1896.

Annual Accounts.

The Chairman concluded by speaking of the net result of the two stations working.

Subjoined to the above report is an appendix by Mr. Sydney W. Baynes, chief electrical engineer, giving details of the cost of working at the King's Road works. Mr. Baynes says:—

APPENDIX.

King's Road Works.

An analysis of the accounts has been made and tabulated along with those obtained at several stations of approximately the same output or capital expenditure. From this table it can readily be seen in what respect the expenses incurred at King's Road are in excess of other stations.

The large number of units used on the works is consequent on the auxiliary machinery being driven by electro-motors, while in most other works steam is the motive power; 53,300 units have been used for this purpose alone, leaving 28,600 B.T. units for station lighting and testing purposes. It should also be noted that the whole cost of current used for lighting and testing purposes at 57, Pratt Street, has been borne by the King's Road station, and these units do not appear as units sold, although they must be accounted for and have been duly metered to Pratt Street offices. The current actually unaccounted for is exceedingly small.

Coal, 1·63d. per B.T.U. Sold.

It will be seen that this figure compares favourably with those of other stations for similar periods, and is slightly less than that obtained for the first 15 months' working at Stanhope Street, which had the advantage of more than double the output. The cost under this heading would have been materially reduced had it not been for the fact that during the greater part of the time the engines were running at very light loads, and consequently taking a large amount of steam per unit generated.

Since the new Peache engine has been in use, it has been possible to shut down the motor generators during the day and thus effect a further economy.

Oil, Water and Stores, 0·48d. per B.T.U. Sold.

This figure compares unfavourably at first sight with the results of other works in their initial stages. £112 has been spent in oil, but nearly half of this quantity was *actually consumed in trial runs and generating current, &c.*, up to year ending 1895. In the early running of the engines the contractor encountered considerable difficulties in preventing the oil from escaping through the glands to waste, and as

King's Road Station.

1895-96.

Units sold 164,209
Units generated... ... 265,924

	Amount paid.	Per unit sold.	Per unit generated.		Per unit sold.	Per unit generated.
Generating—	£ s. d.	d.	d.		d.	d.
Coal	1,371 4 10	2·004	1·237			
Oil, water, &c.	334 3 7	0·488	0·301	Oil	0·163	0·104
				Water	0·250	0·154
				General stores ...	0·074	0·042
Wages on station	1,142 12 5	1·670	1·031			
Repairs and maintenance and petty expenses ...	292 10 4	0·427	0 264			
		4·589	2·834			
Distribution—						
Wages	64 13 11	·094	·058			
Repairs and maintenance (including arc lamps) ...	272 13 9	·398	·246			
		·492	·304			
Royalties, rates and taxes	181 18 4	·265	·164			
Management	529 12 3	·774	·477			
Stationery and general establishment charges ...	311 7 3	·455	·281			
Law and special charges	302 5 7	·441	·272			
	£4,803 2 3	1 935	1·195			

Total cost per unit sold, 7·020d. Total cost per unit generated, 4·334d.

Results of First Year's Working of a Few Central Stations in Comparison with King's Road Works.

Name of station.	Capital invested at end of first year.	Revenue. By sale of current.	Revenue. Meter rents, &c., as per B.T.R.	Interest and repayment. Interest.	Interest and repayment. Repayment.	Gross loss on working.	B.T.U. sold.	Cost per B.T.U. sold. Coal.	Oil, water and stores.	Wages.	Repairs, maintenance.	Total works cost.	Rent, rates, and taxes.	Management and office expenses.	Interest on capital.	Repayment.	Total costs (less distribution).
	£	£	£	£	£	£		d	d	d	d	d	d	d	d	d	d
	b	c					a	d									
King's Road, 15 months.	59,787	3,579	177	3,236	639	4,766	164,209	1·63	0·48	1·67	0·32	4·10	0·26	1 68	4·12	0·93	11·09
Stanhope Street, 14 months.	91,269	10,207	153	3,719	400	1,543	433,519	1·66	0·25	1·25	0 16	3·32	nil.	1 14	2·05	0 22	6·73
Hampstead, 15 months.	56,522	4,200	145	1,450	464	2,916	92,527	2·53	0·44	1·19	0·52	4·68	0·49	1·49	1·80	0 57	9·03
Brighton, 12 months.	53,173	4,543	229	nil.	nil.	...	156,110	0·22	0·22	1·09	0·06	2 59	0 08	1·17	nil.	nil.	3·76

Note (a) 175,377 B.T.U., less 11,168 supplied to Stanhope Street = 164,209 B.T.U.
" (b) £64,633, less £4,846 for destructor works = £59,787 capital expended.
" (c) £3,824, less £245 for current supplied by Stanhope Street = £3,579 by sale of current.
" (d) £1,371 4s. 10d., less £252 10s. estimated amount for steam supplied to destructors, additional coal used in consequence of leakage and repairs to boilers = £1,118 14s. 10d. for coal generating current.

Sydney W. Baynes, *Chief Electrical Engineer.*

a consequence the expenditure for oil was abnormally high. It is customary in the case of new works for the contractor to defray the expenses incidental to testing and efficient installation of the plant; in the present case all has been debited to the cost of generating current.

The water account is heavy in consequence of the persistent leakage of the boilers, which further entailed their being repeatedly emptied to facilitate the process of caulking. The underground storage tank of 115,000 gallons had likewise to be emptied, because of leakage, before the works were in operation; and as the water account under review includes a large quantity of water used during the construction of the works, it is not difficult to account for the (at first sight) apparently large quantity consumed. The price demanded for 1,000 gallons is 8½d., as against 6d. for Regent's Park works.

WAGES, 1·67D. PER B.T.U. SOLD.

This item is large, but is a standing charge which will not increase materially with the growing output of the station, and it may be mentioned that had the output from King's Road been as great as that from Stanhope Street during its first 15 months running, the figures would have been reduced from 1·67d. to about 0·63d. per B.T.U.

TOTAL WORKS COSTS, 4·1D. PER B.T.U. SOLD.

Although this figure is in excess of that obtained at Stanhope Street, the difference, as explained above, is chiefly caused by the great difference in the output from the two stations, and taking into consideration the difficulties which had to be contended with, cannot be considered an unsatisfactory result. As the average price obtained per B.T.U. is about 5·2d., it will be seen that in the actual working expenses of the station there is a gross profit of 1·1d. per B.T.U. sold.

When comparing the tabulated results annexed, we find that for these works, the figures for interest and repayment of capital, viz., 5·05 pence per unit sold, are phenomenally high contrasted with other undertakings; take, for instance, Hampstead's 2·37, or Brighton's *nil*.

It is evident that whilst the works under control of this committee are encumbered with the accumulated interest and repayment charges which other stations are allowed to transfer to capital account, comparisons cannot be instituted, and it is unfortunate for the records of the St. Pancras Works that they appear in the technical Press under such unfavourable conditions.

Had our figures been dealt with in a similar manner to Brighton's and other works in their initial stages, the result of the year's working of the combined stations would have shown a handsome profit.

There is also the sum of £290 13s. 2d. due to the King's Road accounts for the rental, &c., of land in connection with the destructor works, which does not appear as an asset in the balance-sheet.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1897.

[*Compiled expressly for this journal by* W. P. THOMPSON & Co., *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.*]

10,994. "Improvements in electric arc lamps." F. S. WORSLEY. Dated May 3rd.

10,995. "Improvements in carbon holders for electric arc lamps." F. S. WORSLEY. Dated May 3rd.

11,009. "Improvements in the manufacture of incandescent electric lamps." W. E. BARRAS. Dated May 3rd.

11,017. "Improvements in telegraph cables or the like." J. J. HALL. Dated May 3rd.

11,022. "Improvements in telegraph keys." A. C. ROBINSON. Dated May 4th.

11,045. "Improved apparatus for supplying or measuring a current of electricity." W. D. WATSON and T. HUMPHREYS. Dated May 4th.

11,051. "Improvements in ceiling roses for electrical purposes." W. P. THEERMANN. Dated May 4th.

11,058. "Improvements in electric meters applicable also to instruments for testing the magnetic properties of iron." J. FINLAYSON. Dated May 4th.

11,086. "Improvements in electro-pneumatic steering gear for vessels." A. J. BOULT. (C. E. Creecy, United States.) Dated May 4th. (*Complete.*)

11,124. "Improvements in electric lamp holders." E. L. JOSEPH. Dated May 4th. (*Complete.*)

11,148. "Improvements in alternating current motors." R. BELFIELD. (B. G. Lamme, United States.) Dated May 4th.

11,149. "Improved methods of and means for controlling electric motors." R. BELFIELD. (The Westinghouse Electric and Manufacturing Company, United States.) Dated May 4th.

11,155. "Improvements in or relating to electric arc lamps." A. J. BOULT. (E. A. Pellett and J. Dejardin, France.) Dated May 4th.

11,190. "Improvements in the electrolysis of fused zinc chloride." F. M. LYTE. Dated May 5th.

11,199. "A combination automatic action cut-out and trigger switch for governing the speed of vehicles worked by electricity or other power." J. F. O'NEILL. Dated May 5th.

11,224. "Improvements in electricity meters." CHAMBERLAIN AND HOOKHEM, LTD., and S. H. HOLDEN. Dated May 5th.

11,226. "Improvements in telephones." E. PRIDDLE. Dated May 5th.

11,231. "Improvements in dry batteries." E. GIGLIO. Dated May 5th.

11,236. "An improved process and means for electrically purifying liquids." D. REYNOLDS. Dated May 5th.

11,270. "Improvement in electrical connections for theatrical stage purposes." W. H. WILLIAMS. Dated May 6th.

11,317. "Improvements in electrical signal systems for railways." L. C. WERNER. Dated May 6th.

11,320. "An improvement in electric fuse heads for blasting and for other purposes." G. PETTINGER. Dated May 6th.

11,334. "Improvements in electric ignition devices for gas engines and other gaseous explosive mixture engines." J. VAUGHAN-SHERRIN. Dated May 6th.

11,337. "Improvements in or relating to sockets or holders for incandescent electric lamps, and the attachment of lamps thereto." A. J. BOULT. (E. Worringen, Holland.) Dated May 6th. (*Complete.*)

11,355. "Improved means for attaching shades to electric incandescent lamp holders. H. H. HALL and T. CLARKE. Dated May 7th.

11,383. "Improvements in electric heel plates, and like articles." J. W. GIBBS. Dated May 7th.

11,413. "Improved electrical signalling apparatus for transmitting commands and the like." C. D. ABEL. (Allgemeine Elektricitäts Gesellschaft, Germany.) Dated May 7th. (*Complete.*)

11,480. "A new method of making and breaking an electric circuit." C. NEWMAN. Dated May 8th.

11,497. "Electrical advertising apparatus." J. S. COLLETT. Dated May 8th.

11,507. "Improvements in apparatus for electro-plating small ware." W. BROWN. Dated May 8th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. THOMPSON & Co., 322, High Holborn, W.C., *price, post free,* 8½*d,* (*in stamps*).]

1897.

2,789. "Improvements in storage batteries." H. S. LLOYD. Dated February 2nd, 1897. The invention relates to certain improvements in storage batteries and has for its object to provide a battery in the form of a series of cells or sections which may be readily fitted together and the number of sections or separate cells increased to any desired extent without a corresponding increase in the area of floor space occupied, the cells or sections being uniform and interchangeable and adapted to be placed in a vertical pile of any height. The electrolyte is poured into an opening formed above the top cell and permitting it to overflow from cell to cell until all are supplied. Suitable arrangements are provided to allow of the escape of gases generated by the chemical reactions within the battery. A more economical action of the electrodes is provided by their being completely submerged, thus preventing deterioration which occurs at liquid level. 13 claims.

3,470. "Improvements in clamp connections for electrical conductors." SIEMENS BROS. & Co., LIMITED. (Siemens & Halske.) Dated February 9th, 1897. The invention relates to an improved construction of clamp connection for electrical conductors whereby branch conductors can be reliably and readily connected to a continuous main conductor, or generally two conductors can be effectually connected together. The essential feature of the invention consists in so arranging the parts constituting the clamp connection that by means of a single screw the main conductor and the branch are each independently connected to the clamp with a considerable amount of contact surface that are pressed together by the full force exerted by the screw without requiring any special preparation of the main conductor for this purpose, while the branch conductor has its end bent into a loop. 4 claims.

3,471. "Safety cut-outs for electric circuits." SIEMENS BROS. AND Co., LTD. (Siemens & Halske.) Dated February 9th, 1897. Relates to a safety cut-out wherein one or more fuses are contained within closed zig-zag or serpentine channels, so arranged to be of considerably greater length than the distance between the pole plates or terminals to which the ends of the fuse are attached, such passages being provided with lateral holes for the escape of the metallic vapours resulting from the burning of the fuse. 4 claims.

3,906. "Improved electrically operated switch tongue for railways and tramways." E. ANDRE and A. SILBERMANN. Dated February 13th, 1897. Relates to a means for operating the switch tongue of rails for electric cars from the driver's platform. The invention consists of an electro-magnet which may be thrown from one side of the switch to the other, and excited so as to attract and throw over the switch tongue in the desired direction. 3 claims.

4,979. "Improvements in station indicators for electric railways or tramways." I. STEFFEN. Dated February 24th, 1897. The invention relates to station indicators specially designed for electrically propelled vehicles running upon lines of rails, and its object is to provide an arrangement whereby stations on country lines and in cities may be automatically and plainly presented to the view of all the passengers in the car.

5,477. "Improvements in and relating to arc lamps." W. G. HEYS. (The Puritan Electric Company.) Dated March 2nd, 1897. Relates to a method of starting an alternating current arc lamp in operation which consists in holding the carbons in contact after the current is turned on, long enough to allow the carbons to become heated sufficiently to maintain the normal arc, and then slowly operating the carbons to establish the arc. 8 claims.